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ABSTRACT

This manual provides information needed to meet the standards for pesticide applicator certification. Pests and diseases of Christmas tree plantations are identified and discussed. Section one deals with weeds and woody plants and the application, formulation and effects of herbicides in controlling them. Section two discusses specific diseases and their control. Insect and rodent pests are identified and suggested control measures are given in parts three and four. (CS)

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COOPERATIVE EXTENSION SERVICE

University of New Hampshire

CHRISTMAS TREE CATEGORY MANUAL

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COMMERCIAL PESTICIDE APPLICATOR TRAINING

This training manual is intended to provide you with the information you will need to meet the standards of the E.P.A. for pesticide applicator certification, and prepare you to take an examination given by the State of New Hampshire, Dept. of Agriculture based on this manual. It is not intended to provide you with all the information you need for effective pest control. Additional information in the form of publications and short courses can be obtained from the Cooperative Extension Service.

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INTRODUCTION TO
WEEDS AND HERBICIDES

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A weed is a plant out of place, one which interferes with man's utilization of land. Weeds may occur as native or as introduced flora; 60 percent are introduced. Ten commonly accepted characteristics of weeds, in order of importance are:

<u>Characteristic</u>	<u>Additional Comments</u>
Indiscriminate, grows where not desired	Large; able to thrive anywhere
Competitive, aggressive	Reproduces many ways; establishes quickly; grows under poor conditions
Wild. rank	Large; grows quickly over wide area; is nitrogen-loving
Persistent, resistant,	Reproduces many ways; is protected from herbicides by form, biochemical tolerance, seed dormancy, or perennial nature.
Abundant	Adapts to crowding; has high seed numbers; is near mother plant
Useless and undesirable	Has no forage value, except perhaps as ground cover
Harmful to man, animals, crops	Has thorns or fibers; is poisonous, parasitic, or toxic
Spontaneous, not sown	Buried seed or parts are small and dormant; is sensitive and adaptable to tillage, crop cycles, and high fertility
Highly reproductive	Special structures aid dispersal; seeds are dormant
Unsightly	Is dominant, aggressive, unattractive in flowers or foliage; replaces desirable forms

NAMING WEEDS

All plants have a true, or scientific, name and a common name. The first word of the scientific name refers to genus; the second word to species. For example, Cyperus esculentus is the true name for yellow nutsedge.

Common names for any plant may differ from place to place. For example,

Agropyron repens is called quackgrass by the Weed Science Society of America, wiregrass in Pennsylvania, and couchgrass in Canada and England.

Discussing weeds is easiest if common names are used, but efforts to standardize common names are only partially successful. Botanical names are awkward for general use, but are used in weed control literature to avoid confusion.

HOW WEEDS CAUSE LOSSES

Weeds cost Pennsylvanians at least \$127 million each year: more than \$100 million in field and forage crops; \$15 million in horticultural crops; and more than \$12 million in noncropland areas.

Weeds can host nematodes, or fungus and virus diseases; they can cause allergic reactions; they can taint food; and some can cause physical disorders or death. They also compete with crops, and interfere with planting, harvesting, and machinery efficiency. Some simply do not look good in a landscape.

SPREAD AND GROWTH OF WEEDS

DISPERSAL

Weed seeds are dispersed by natural forces and by animals or humans.

Natural forces include wind and water. Some weed seeds are small enough to be carried by water, and others, such as dandelion, are adapted to be moved by wind currents. In water, many seeds can float without damage.

Animals may carry seeds on barbs which attach to their hide or hair: beggarsticks and cocklebur are spread this way. Domestic animals may pass seeds through the digestive tract, infesting fields with weeds. If Johnsongrass appears near to feed lots, it will probably spread to fields. Birds spread weeds when intact seeds are passed through the digestive tract; mulberry and bitter nightshade are commonly spread by birds.

Man moves weed seed from one location to another in agricultural products, on machinery and clothing--in anything he handles. With equipment, he may drag tubers of nutsedge or rhizomes of quackgrass from one spot to another in fields.

DORMANCY

Seed dormancy is a survival mechanism for weeds. The three categories of seed dormancy are innate, induced, and enforced. The primary factors which affect dormancy are light, temperature, moisture, oxygen, afterripening, developmental stage of embryo, and condition and composition of seed coat.

INNATE DORMANCY

Innate dormancy means that after the seed leaves the parent plant, it requires some afterripening treatment, further development of immature embryos, leaching of natural inhibitors, or exposure to temperature extremes before germination can occur.

Seeds of different weed species vary in reaction to temperature. Crops are generally planted at or near optimum soil temperature for quick germination, but that may also be an ideal temperature for weed seeds.

Many seeds have a temporary dormancy which is broken by either low or high temperatures, preventing germination in the same season the seeds are produced and allowing the seeds to survive adverse weather conditions.

Water is required for germination. In dry soils, seeds may remain dormant until all other factors involved in promotion of germination reach at least a minimum level.

Seed coats may be waterproof, as are the coffeeweed seeds with their hard wax-like material over a dense covering around the embryo. Other hardseeds are morningglory, lespedeza, clover, and vetch.

Crop competition (shading) may intercept light rays and reduce weed seed germination when crops are in advanced stages of maturity.

The availability of oxygen is another factor which affects germination. Seeds may begin to germinate without air (anaerobic) and then shift to aerobic conditions when the seed coats rupture. Water may fill soil pores and exclude air, interfering with germination. Soil compaction may reduce the oxygen supply. Not cultivating at layby time keeps oxygen down, lowering the chances of germination.

INDUCED DORMANCY

Induced dormancy develops when a seed is exposed to specific environmental conditions, such as high soil temperatures, and becomes dormant. The dormancy lingers after conditions change. Yellow foxtail and smartweed react this way, and the seeds survive until the following spring when germination can occur.

ENFORCED DORMANCY

Enforced dormancy refers to environmental limitations which prevent germination. When the limitations are removed, seeds germinate freely. Plowing, deep tillage, or planting operations bring buried seed to the surface where they germinate readily. Special devices on turning plows bury weed seed at the bottom of the preceding furrow slice and enforce dormancy.

CONDITIONS AFFECTING WEED SEED GERMINATION

BURNING

Burning fields to destroy weed seed gives varying results, depending on heat intensity and duration. Many common weed seeds are destroyed when exposed to very high temperatures (175° to 212° F.) for 15 minutes. But if the burning creates only moderate heat, it may end dormancy of many seeds and induce increased germination because of greater temperature alternation, more light, less competition, and the removal of litter.

CUTTING

A common recommendation is to mow weeds to prevent seed production. The success of mowing depends upon proper timing.

Mowing when or before flower buds form prevents production of viable seed. But if flowers are open at mowing, much of the live seed falls back to the soil. Mowers often miss short-stemmed flowers which produce large numbers of seed.

STORAGE IN SILAGE

In storage, organic acids in silage kill many weed seeds within 10 to 20 days. However, some weed seeds may germinate after four years of silo storage.

SURVIVAL IN MANURE

Fresh manure spreads live weed seed, but well-rotted manure is generally free of living seed.

WEED REPRODUCTION

Weeds reproduce sexually or asexually. Sexual refers to those weeds that propagate by seed; asexual to those that reproduce by vegetative means such as runners, roots, or rhizomes.

HERBICIDES

Herbicides are chemicals used to kill plants or to interrupt normal plant growth. These chemicals can be classified in several ways: effect on plants; application time; application method; and similarity of chemical structure.

EFFECT ON PLANTS

Classification of herbicides by toxic effects is probably the most useful.

TRANSLOCATED HERBICIDES

Translocated (systemic) herbicides are absorbed by roots or leaves and distributed throughout the plant. The three groups of systemic herbicides are growth regulators, photosynthesis inhibitors, and cell-growth inhibitors.

GROWTH-REGULATING HERBICIDES

2,4-D	2,4-DEP (Falone)	MCPB
2,4,5-T	silvex	dicamba (Banvel D)
2,4-DB (Butoxone, Butyrac)	MCPA	picloram (Tordon)
		sesone

These herbicides cause responses similar to those of natural growth-regulating substances called auxins. Application of artificial auxins, such as 2,4-D, upsets normal growth as follows:

1. The cells of leaf veins rapidly divide and elongate, while cells between veins cease to divide. This results in a long, narrow, strap-like appearance of young leaves.
2. Water content increases, causing treated plants to be very brittle and easily broken.
3. Cell division and respiration rates increase; photosynthesis decreases. The food supply of treated plants is nearly exhausted at time of death.
4. Roots of treated plants lose their ability to take up soil nutrients, and stem tissues fail to move food effectively through the plant.

The killing action of the growth-regulating chemicals is not due to any single factor; plant death comes from the effect of several disturbances in the treated plant.

INJURY SYMPTOMS OF GROWTH-REGULATING HERBICIDES

On broadleaf plants, the leaves are crinkled, puckered, strap-shaped, stunted, and malformed; the leaf veins appear parallel, rather than netted; and stems are crooked and brittle, with shortened internodes.

On grasses (corn, for example), growth-regulating herbicides cause leaves to roll near the base in an onion-like fashion; the tip of the terminal leaf is free; and stems are brittle, curved or crooked, and have short internodes.

HERBICIDES INHIBITING PHOTOSYNTHESIS

In the presence of light, green plants produce sugar from carbon dioxide and water. Energy is required to rearrange carbon, hydrogen, and oxygen atoms to form sugar. For this necessary energy, electrons are borrowed from chlorophyll (the green material in leaves), and replaced by electrons split from water. If chlorophyll electrons are not replaced, the chlorophyll is destroyed and the plant's food manufacturing system breaks down.

The triazine, substituted urea, and uracil herbicides all block chlorophyll electron replacement. As preemergence treatments, these herbicides permit normal seed germination and seedling emergence, but cause the seedlings to lose their green color soon after emergence. The seedlings die after the food supply in the seed is gone. At low rates, these herbicides are more effective on seedling weeds than on established weeds.

Inhibitors of Photosynthesis:

Triazines: atrazine, simazine (Princep), prometryne (Caparol), propazine (Milogard), prometone (Pramitol), cyanazine (Bladex), cyprazine (Outfox)

Uracils: terbacil (Sinbar), bromacil (Hyvar X)

Substituted ureas: diuron (Karmex), fluometuron (Cotoran), norea (Herban), linuron (Lorox), chloroxuron (Tenoran), fenuron (Dybar), monuron (Telvar)

INJURY SYMPTOMS OF PHOTOSYNTHESIS-INHIBITING HERBICIDES

On broadleaf plants, early seedling growth appears normal, but shortly after emergence, leaves become mottled, then turn yellow to brown and die.

Grasses germinate and grow normally to the two- or three-leaf stage; then the leaves turn light green to white and the seedling dies.

HERBICIDES INHIBITING CELL GROWTH

Herbicides in this group cause abnormal cell development or prevent cell division. The carbamate herbicides prevent cell division in roots and shoots

while permitting other cell duplication processes to continue. This causes death of bud tissues and eventually plant death.

The nitroanilines also prevent cell division. They act primarily on developing roots.

Dalapon prevents cell division, but apparently kills plants by preventing the production of a vitamin. Dalapon acts primarily on shoot tissue.

INJURY SYMPTOMS OF CELL-GROWTH-INHIBITING HERBICIDES

Carbamates: chlorpropham (Chloro IPC) vernolate (Vernam)
EPTC (Eptam) butylate (Sutan)

On broadleaf plants, the leaves turn dark green, become wrinkled, and fail to unfold from the bud; the roots are shortened, thickened, brittle and club-like.

Young leaves of grasses fail to unfold, resulting in a crooked-neck, onion-like appearance; the tip of the terminal leaf is rigid and not free-flapping (flag-like); the roots are shortened, thickened, brittle, and club-like.

Nitroanilines: trifluralin (Treflan) benefin (Balan)
profluralin (Tolban) dinitramine (Cobex)
penoxalin (Prowl) butralin (Amex 820)

Seeds of treated broadleaf plants germinate but fail to emerge or emerge as severely stunted seedlings; seedlings have a thickened, shortened lower stem, small leaves and short, club-shaped roots.

Grass seeds germinate but generally fail to emerge; injured seedlings have short, club-shaped roots, and thickened, brittle stem tissue.

Dalapon: Dowpon

On broadleaf plants, the leaves are brown, with a burned appearance; stems may be twisted; and flowers, if present, are deformed.

Grasses treated with dalapon have leaves which become straw-colored several days after treatment; young leaves may fail to unfold, resulting in an onion-like appearance.

CONTACT HERBICIDES

Contact herbicides are non-selective and are sometimes called caustic herbicides; they appear to burn plant tissues. The burn results from cellular breakdown by:

- a. Direct injury to cell membranes: Phytotoxic herbicidal oils kill plants by dissolving parts of the cell wall.
- b. Protein coagulation: Dinoseb (Dinitro) and PCP cause coagulation of proteins, and rapid plant death.
- c. Inhibition of photosynthesis: Paraquat, diquat, linuron (Lorox) and prometryne (Caparol) oxidize chlorophyll and cause a buildup

of toxic materials which results in rapid death of treated tissues. The activity of these herbicides is delayed in the absence of light.

SOIL STERILANTS

Soil sterilants are a group of non-selective chemicals which keep the soil free of vegetation for one or more years. Many herbicides can be used as soil sterilants if applied at very high rates.

TIME AND METHOD OF APPLICATION

Herbicides can be broadly classified by time or method of application.

TIME

PREPLANT: Applied to the soil before crop planting. Example: butylate (Sutan) on corn.

PREEMERGENCE: Applied after crop is planted but before weeds emerge. Example: atrazine on corn.

POSTEMERGENCE: Applied after crop and weeds emerge. Example: dicamba (Banvel) on corn.

METHOD

BROADCAST: Applied over the entire field.

BAND: Applied to a narrow strip over crop drill row.

DIRECTED: Applied as a band directed toward the base of crop plant.

SPOT TREATMENT: Applied to small areas within a field.

STRUCTURE

Herbicides are often grouped together on the basis of similarity of chemical structure.

ORGANIC HERBICIDES

1. AROMATIC CARBOXYLIC ACIDS

Phenoxy herbicides:

2,4-D	
2,4,5-T	
2,4-DES	(Sesone)
2,4-DB	(Butyrac 200, Butoxone)
2,4-DEP	(Falone)
MCPA	(Methoxon)
MCPB	(Cantrol, Thistrol)

Benzoic acids:

dicamba	(Banvel D)
TIBA	
2,3,6-TBA	(Trysben, Benzac)
chloramben	(Amiben)

Phthalic acids:

naptalam	(Alanap)
DCPA	(Daethal)

2. ALIPHATIC ACIDS

dalapon	(Dowpon)
TCA	(TCA)

Organic arsenical herbicides:

MSMA	(Ansar 170)
DSMA	(Ansar 184, Clout)
MAMA	(Ansar 157)
AMA	(Methar)
CMA	(Calar, Crab-E-Rad)
cacodylic acid	(Phytar, Erase)

3. HETEROCYCLIC NITROGEN DERIVATIVES

Ring substituted triazines:

ametryne	(Erik)
atrazine	
cyanazine	(Bladex)
cyprazine	(Outfox)
metribuzin	(Lexone, Sencor)
prometone	(Pramitol)
prometryne	(Caparol)
propazine	(Milogard)
simazine	(Princep)
procyzine	(Cycle)

Substituted uracils:

terbacil	(Sinbar)
bromacil	(Hyvar X)

Other heterocyclic nitrogen derivatives:

amitrole	(Amitrol)
picloram	(Tordon)
maleic hydrazide	(MI-30)

4. ALIPHATIC NITROGEN DERIVATIVES

Substituted ureas:

diuron	(Karmex)
norea	(Herban)
fluometuron	(Cotoran)
linuron	(Lorox)
chlorbromuron	(Maloran)
chloroxuron	(Tenoran)
fenuron	(Dybar)
manuron	(Telvar)

Substituted amides:

diphenamid	(Enide, Dymid)
CDAA	(Radox)
propachlor	(Ramrod)
alachlor	(Lasso)
propanil	(Stam)

Carbamates:

chloropropham	(Chloro IPC)
EPTC	(Eptam)
vernolate	(Vernam)
pebulate	(Tillam)
butylate	(Sutan)
prophram	(ICA Chem-Hoe)
barban	(Carbonyne)
terbutol	(Azak)
CDEC	(Vegadex)
triallate	(Avadex BW)

5. NITROANILINES

trifluralin	(Treflan)
bifenox	(Balan)
penoxalin	(Prowl)

6. SUBSTITUTED NITRILES

dichlobenil	(Casoron)
ioxynil	(Certol, Actril)
bromoxynil	(Brominal, Buctril)

7. SUBSTITUTED PHENOLS

dinoseb	(DNBP)
DNOC	(Sinox)
PCP	(Penta)

8. METAL ORGANIC HERBICIDES

sodium chlorate
calcium cyanamide (cyanamid)
sodium cyanate
potassium cyanate
phenyl mercuric acetate (PMA)
ammonium sulfamate (Ammate)

INORGANIC HERBICIDES

Sodium borate; arsenic trioxide; sodium arsenite; copper sulfate.

HERBICIDE FORMULATIONS

Herbicides are sold not as pure chemicals but as a combination or formulation of one or more herbicides with various additives. Surfactants, emulsifiers, adhesives, or various diluents may change the activity of a pure herbicide to the advantage of the user. Toxicity to plants, uniformity of plant coverage, and stability in storage depend on formulation. However, the primary function of formulation is to permit uniformity and ease of application. Herbicides are formulated to be applied as sprays, granules, or dusts.

SPRAYS

SOLUTIONS are homogeneous mixtures of two or more substances. A solution may be either clear or colored and cannot be separated by mechanical means. An example of a solution is 2,4-D amine dissolved in water.

EMULSIONS are one liquid dispersed in another, such as 2,4-D esters dispersed in water. Emulsions appear milky when dispersed in water. Without agitation, the liquids may separate.

WETTABLE POWDERS are finely divided solid particles that may be dispersed or suspended in water. Suspensions of wettable powders appear cloudy. Wettable powders are nearly insoluble and require agitation to remain in suspension. Atrazine and linuron are formulated as wettable powders.

GRANULES

Herbicides in granular formulations are applied in a dry state with a carrier. The carrier may be clay, sand, vermiculite, or ground corn cobs. Performance of granulated herbicides, compared with sprayable formulations, varies with the herbicide. Granular forms generally require more rainfall for activation than do sprayable formulations.

Advantages:

Water is not needed for application.
Relatively inexpensive equipment can be used for application.
May be very selective because granular particles fall off leaves, and sift through a canopy to the ground.

Disadvantages:

Heavy, bulky, troublesome to store or ship.
Small granules are subject to drift.
Application is not as uniform as sprays.

DUSTS

Dusts are popular formulations of insecticides and fungicides. Because of drift hazard, few herbicides are applied as dusts.

HERBICIDE-LIQUID FERTILIZER COMBINATIONS

Herbicides may be combined with liquid fertilizers to minimize trips over the field. Information is scarce concerning compatibility of herbicides with specific fertilizer solutions. Herbicide-fertilizer solution combinations may form a gel that will not flow through sprayer equipment. Other combinations may form solids that settle to the bottom of the sprayer tanks. The compatibility of herbicide-fertilizer combinations should be tested prior to mixing the components for field applications. In some cases, addition of a surfactant (Compex, Buffer X, or comparable surfactants) may aid in maintaining component dispersion.

The following procedure may be used to test the compatibility of herbicides with liquid fertilizers:

1. Fill two one-quart jars with the fertilizer solution to be tested. Add one teaspoon of surfactant to one of the jars.
2. Add the necessary amount of herbicide (as specified by the chart below).

Gallons of Liquid
Fertilizer Per Acre*

Herbicide to be Added Per
Quart of Fertilizer Solution**

10	5.0 teaspoons
15	3.0 "
20	2.5 "
25	2.0 "
30	1.5 "
50	1.0 "
100	0.5 "

* Test the components at the temperature that will exist in the field at application time. Incompatibility problems are most serious at low temperatures.

** The amounts listed are equivalent to approximately one quart of liquid herbicide or two pounds of wettable powder herbicide as the commercial formulation per acre.

Observation:

1. If, after standing for ten minutes, the components in the jar with no surfactant are dispersed, the herbicide is compatible and no surfactant is needed.
2. If the components are dispersed only in the jar containing surfactant, the herbicide is compatible only if a surfactant is added.
3. Should the components not be dispersed in either jar, then the herbicide-fertilizer solution mixture is not compatible and should not be used.

Should the herbicide-fertilizer mixture prove compatible in this test procedure, it may be applied as a mixture on a field basis, provided vigorous agitation is maintained in the spray tank.

HERBICIDE SAFETY

Recommended herbicides will not cause injury to humans, livestock, wildlife or crops if used properly and if recommended precautions are observed. However, any herbicide is potentially dangerous if improperly handled or used. Avoid splash or spray contact, and keep exposure to a minimum. Never keep herbicides in containers that are improperly labeled or easily accessible to children. Never dump unused herbicides where water supplies may be contaminated.

Most commonly available herbicides are given in the following table. They are listed in order of decreasing oral toxicity.

HIGHLY TOXIC HERBICIDES

(probable lethal dose for a 150-pound man
is a few drops to 1 teaspoon)

Sodium arsenite ^{1,2}
Dinoseb (DNBP, Dinitro) ¹

Endothall (Aquathol, Des-i-cate) ³

TOXIC HERBICIDES

(probable lethal dose for a 150-pound man
is 1 teaspoon to 1 ounce)

Arsenic
PCP (Sod. Salt) ¹
Copper Sulfate (Bluestone)
Diquat

Paraquat
DMPA (Zytron) ⁴
2,4-D (acid) ⁴
2,4,5-T (acid and ester) ⁴

MODERATELY TOXIC HERBICIDES

(probable lethal dose for a 150-pound man
is 1 ounce to 1 pint or 1 pound)

DSMA (Ansar 184, Clouc)
MCPA (acid)
2,4-DB (Est'd) ³
CDEC (Vegadex) ³
Calcium Cyanamide (Cyanamid)
Dibenzamid (Dymid, Enide)
MCPA (amine)
Linuron (Lerox)
EPTC (Eptam)
Vernolate (Vernam)
Arsenic acid
Norea (herban)
DCPA (Dacthal)
Dicryl (Chloranocryl)
Monuron (Telvar) ⁴
Chloroxuron (Tenoran)
Dalapon (Dowpon) ⁴
Simazine (Princep)
Amitrol-T (Cytrol)

2,4-D (Sod. Salt)
2,4-D (Isop. ester)
AMA (Methar)
2,4-DES (Sesone)
Dicamba (Banvel-D)
Pebulate (Tillam)
Cacodylic acid (Phytar, Erase)
AMS (Ammate)
NPA (AlaNap)
Bensulide (Betasan)
Dichlobenil (Casoron)
Prometryne (Caparol)
Atrazine
Diuron (Karmex) ⁴
Chloramben (Amiben)
Prometryne (Caparol)
Propazine (Milgard)
Chlorpropham (CIPC)
Trifluralin (Treflan)

ALMOST NON-TOXIC HERBICIDES

(probable lethal dose for a 150-pound man
is more than 1 pint)

Bromacil (Hyvar X)
MH (Sod. Salt)
Picloram (Tordon)
Benefin (Balan) ⁴
Amitrole (Weedazol) ⁴

Sodium Borate ⁴
Fenuron (Dybar)
Fluometron (Cotolan) ⁴
Sodium Chlorate
Terbutol (Azak)

Dermal response: ¹ is absorbed and poisonous
² causes burns and blisters
³ is moderately irritating
⁴ is mildly irritating

LIVESTOCK SAFETY

Herbicides sprayed on plants are not generally toxic to livestock, but animals may be poisoned by eating unused herbicides left in open containers or by drinking water contaminated with herbicides.

Certain unpalatable or poisonous plants treated with herbicides may become palatable to livestock. Be certain that livestock cannot get to poisonous plants which have been sprayed with herbicides.

The nitrate content of several kinds of weeds may be increased after spraying with 2,4-D, Banvel, or similar herbicides. Cattle browsing on these treated plants may become ill. Remove all animals from sprayed areas for several days or until after rain or after death of the weeds.

Milking dairy cattle should be kept off pastures for seven days after spraying with 2,4-D-type herbicides.

SAFETY TO GAME AND FISH

Controlled spraying may be beneficial to wildlife by maintaining desirable cover. Herbicides recommended for control of aquatic weeds give beneficial results for fish populations. Be sure to apply these herbicides properly. Do not drain or flush equipment where chemicals may wash into ponds or streams, and do not leave open containers where curious animals might find them.

CROP SAFETY

Farmers are occasionally concerned about possible herbicide injury to crops. Most injury of this kind is caused by misuse, contaminated equipment, or drift. Unfavorable weather and herbicide residues from the previous crop are also often associated with herbicide effects on crops.

MISUSE

Improper sprayer calibration, non-uniform application, calculation errors, and use of the wrong chemicals can cause herbicide injury.

Only the recommended amount of herbicide should be applied. Slight increases in rate could result in crop injury or residues which would injure succeeding crops.

It is necessary to recalibrate sprayers frequently to adjust for increased output due to normal nozzle wear. Be sure there is sufficient agitation in the sprayer tank to prevent settling of wettable powders.

Do not stop sprayers in the field, spill tanks when loading, or dump unused herbicides where desirable plants are growing.

The following steps should be taken when mixing herbicides:

1. Calculate the amount of herbicide to add to the sprayer tank on the basis of the active material in each gallon of herbicidal concentrate or the percentage of active ingredient of wettable powder.
2. Read and follow the instructions on the manufacturer's label pertaining to personal hazards in handling.
3. Never pour concentrated herbicides into an empty tank.
 - *First fill the tank half-way with water.
 - *Operate sprayer by-pass to mix thoroughly and to maintain suspension by continuous agitation.
 - *Add the herbicidal concentrate.
 - *Finish filling the tank with water.
4. To ensure thorough mixing, operate the sprayer rig with the control valve closed for several minutes. This by-passes the liquid into the tank.
5. Never allow a sprayer containing mixed chemicals to stand without agitation. Heavy wettable powders may clog nozzles or settle into corners of the spray tank.
6. Always be sure the sprayer has been calibrated properly to ensure the application of recommended rates.

CONTAMINATED EQUIPMENT

Sprayers used to apply 2,4-D-type herbicides may be used to apply other chemicals before crops are planted or before crop plants emerge, but equipment must be thoroughly cleaned before applications are made to emerged crops (except grasses). Ester formulations are harder to remove than are amine or salt formulations.

To remove esters, flush out the entire system with a water-detergent solution immediately after spraying. Then fill the tank and prime the system with an ammonia solution of one gallon of household ammonia to 100 gallons of water, and leave it undisturbed for 12 to 24 hours. Take the nozzles apart and soak the caps, screens, bodies, etc., in ammonia solution. (Five pounds of Sal'soda or eight pounds of trisodium phosphate can be substituted for ammonia). Rinse the system thoroughly with water and let it circulate through the sprayer.

For fatone or sesone formulations, follow the recommended procedure for esters, but use five gallons of vinegar instead of one gallon of ammonia.

After using amine or salt formulations or liquid herbicides, clean the equipment by flushing out the entire system with a water-detergent solution, and rinsing with clean water.

Wettable powder residues must be removed immediately after use: Flush the entire system with clean water, then remove sprayer nozzles and clean residues from screens. Rinse the system with a detergent solution followed by clean water. Replace the nozzles. (The herbicide label may suggest special cleaning procedures.)

As a test for a residual herbicide, spray a few plants of a susceptible crop four to five days before using the sprayer on large areas.

DRIFT

The term "drift" is applied to movement of any pesticide through the air to areas not intended for treatment.

Particle drift: At the time of application, small spray droplets or dust particles are carried by air movement from the application area to other areas.

Vapor drift: After application, herbicides evaporate (volatilize) and yield fumes (gases) which are carried on wind currents and deposited on soils or plants in untreated areas.

Drift may injure sensitive crops, ornamentals, gardens, livestock, wildlife, or people, and may contaminate streams, lakes, or buildings. It may contaminate crops and cause illegal or intolerable residues. Excessive drift may mean poor performance in the desired spray area because the application rate is less than expected.

Highly active chemicals present the greatest drift hazard, since extremely small amounts of these chemicals can cause severe problems. For example, growth-regulating herbicides, such as 2,4-D, dicamba, and picloram, at a rate of one ounce per acre, can deform sensitive crops, such as tobacco or tomatoes.

Vapor drift problems can often be avoided by use of non-volatile formulations. Essentially, no vapor drift hazard is involved in the use of amine formulations of 2,4-D.

Particle drift depends on the size of the particle or droplet; and droplet size depends on pressure and nozzle design. Very small particles of fog or mist size present the greatest drift hazard. To minimize particle drift, equipment should be calibrated to create droplets about the size of light rain.

Most nozzles can be adjusted to a pressure which permits droplet formation as a result of surface tension. If nozzles are operated for this pressure, a minimum of mist-sized droplets will be formed. For some nozzles, this pressure may be as little as 10 pounds per square inch; for others, 30 pounds per square inch.

The distance that particles will drift increases with the height of release. Wind velocities are usually lower close to the ground. Therefore, sprays should be released as near the soil surface or vegetation as adequate coverage will permit.

Drift hazard is usually minimized if prevailing winds are blowing away from sensitive crops. However, a sudden shift in wind direction could result in serious damage. If possible, do not apply pesticides when the wind is strong.

High temperatures increase the loss of volatile herbicides. Esters of 2,4-D rapidly evaporate at temperatures above 80° F. The use of such ester formulations should be restricted to fall, winter, and early spring because sensitive plants are not present, and because low temperatures reduce vapor drift hazard.

Drift control should be considered in every pesticide application. Severe problems associated with drift can be avoided by:

1. Using low volatile or non-volatile formulations
2. Using low spray delivery pressures (20-40 pounds per square inch)
3. Applying at high volume
4. Avoiding application of volatile chemicals at high temperatures
5. Spraying when wind speed is low and blowing away from areas that should not be contaminated
6. Leaving border areas unsprayed if they are near sensitive crops

EVALUATIONS OF POSSIBLE HERBICIDE INJURY

Insects, diseases, severe weather (hail, drought, flooding), fertilizer burn, nutrient deficiencies, and many other factors produce symptoms that can be easily confused with herbicide injury. In evaluating crop injury, it is necessary to consider:

1. Are similar symptoms present in treated and untreated areas within the same field or in crops grown in or near the area in question?
2. What is the history of the problem field--the fertility program, cropping sequence, land preparation, and seed source?

Careful consideration of these points will aid in the diagnosis of the problem.

FACTORS AFFECTING HERBICIDE PERSISTENCE

The residual life or length of time that a herbicide persists in the soil is the length of time that weed control can be expected. Residual toxicity, if not taken into consideration when planting in an herbicide-treated field, may injure succeeding crops.

The inactivation, breakdown, and disappearance of herbicides is influenced by soil and environmental factors.

MICROBIAL BREAKDOWN

Microorganisms use all types of organic matter, including organic herbicides, as food supplies. Some herbicides are more readily attacked by microorganisms than others. This is often due to minor differences in chemical structure which permit rapid decomposition in one case and block decomposition in others. Soil temperature, aeration, pH levels, organic matter, and moisture levels favorable for microbial growth promote rapid herbicide breakdown.

LEACHING

Water carries herbicides out of the root zone. The amount lost to leaching depends on soil texture, herbicide solubility, and amount and intensity of rainfall. As a rule, herbicides leach most from sandy soils and least

from clay soils and soils containing a high percentage of organic matter.

ADSORPTION

After application, herbicides may become adsorbed (bound) to clay and organic matter particles. The extent of adsorption increases as the percentage of organic matter and/or clay increases. Adsorption reduces the amount of chemical available to plants, slows leaching, and retards microbial breakdown.

CHEMICAL BREAKDOWN

Herbicides may be activated by reaction with water, salts, acids, and other substances in the soil. These reactions are affected by the same environmental factors that affect microbial breakdown.

VOLATILIZATION

Some herbicides may be rapidly lost as fumes after application. Loss as vapor reduces the persistence of nitroaniline and carbamate herbicides and of dichlobenil. The rate of vapor loss is influenced by soil moisture, temperature, and adsorption.

The loss of herbicides in vapor increases as sand, soil moisture, and soil temperature increases. Incorporation immediately after application prevents this kind of loss.

PHOTODECOMPOSITION

Sunlight may inactivate herbicides. This may be an important factor contributing to activity loss of unincorporated trifluralin (Treflan), nitratin (Planavin), and benefin (Balan). Light exposure of two or more hours reduces the effectiveness of trifluralin and related herbicides, and can be avoided by soil incorporation.

PLANT UPTAKE

Herbicides may be absorbed by plant roots or leaves and be either accumulated or inactivated within the plant. Generally, herbicide removal by plants accounts for a relatively small amount of herbicide loss.

WEEDS, GRASSES, AND WOODY BRUSH IN CHRISTMAS TREES

Most farm crops are grown on tilled fields which are kept weed-free with mechanical or chemical controls. Christmas trees, largely for economic reasons, are grown on abandoned cropland or pastures. The typical vegetation in Christmas tree plantations is sod consisting of perennial grasses and weeds with some annual weeds. This sod aids in retarding erosion but otherwise adversely affects both the growth and quality of Christmas trees, especially when the trees are small.

Sod affects tree growth by competing for water, nutrients, and light. Young trees often succumb to this competition or become severely stunted. Heavy growth of grasses and weeds mat down in winter, causing crooked stems and disfigured lower branches. Fire hazards and rodent problems are increased by unchecked weed growth. Disease and insect outbreaks are encouraged by restricted air movement and favorable growing conditions created by the weeds and grasses. All of these adverse effects contribute to a longer growing period required to produce a quality Christmas tree. One to five years may be added to the rotation by poor weed and grass control.

Mowing between the tree rows has been an accepted method for reducing and retarding the competing weeds and grasses. It is still a common practice with many growers. Mowing reduces the fire hazard, rodent build-up, and some shading, but does not sufficiently reduce competition for moisture or nutrients in critical periods, nor does it control growth close to the trees. When trees are small and difficult to see in the grasses and weeds, many are cut off or damaged by the mower.

Herbicides for weed and grass control in Christmas trees can be effective when used exclusively or in conjunction with conventional mowing. Herbicides kill the competing vegetation close to the trees and near their root zones, thus eliminating many of the problems mentioned above. Soil erosion and frost heaving may occasionally result from complete sod kill by the herbicide. The void caused by a complete herbicide kill is often filled by annual weeds and grasses and by woody shrubs and vines. Weeds and grasses are easily controlled with a subsequent herbicide application the following year.

Woody vegetation, such as common dewberry, can be controlled only with herbicides that may also kill the Christmas trees. Extra precautions must be taken when treating this woody vegetation. If Christmas trees are less than 18 inches tall, they can be covered while the unwanted vegetation near each tree is being sprayed. A plastic cone or inverted tin can nailed to a stick may be used.

The triazine herbicides which are used extensively in Christmas tree plantings must be applied at levels which will be effective but will not leach to the root zone of the tree. Soil texture determines the degree of leaching; light, sandy soils must be treated with the lower concentrations of Princep, given in the table on Page 3. Heavy clay soils, or muck soils high in organic matter should receive the higher concentrations.

Applying bands of Princep over the rows of trees rather than complete broadcast spraying is generally recommended. A two-foot band over rows which are spaced six feet apart requires only one third the amount of herbicide needed in broadcast application. The remaining four-foot sod strip acts as an erosion barrier. To provide better erosion control, the spray bands should follow the contour as near as possible.

Scattered clumps of woody brush in the Christmas tree plantation should be treated with a herbicide before planting. If this has not been done, or if some woody brush becomes established in the plantation later, treat the woody brush with a dormant basal stem spray containing a 2,4,5-T formulation in oil. Exercise care to keep spray from reaching foliage of the Christmas tree. Three of the woody species which invade Christmas tree plantations require one or two follow-up sprays for a complete kill: black locust, smooth sumac, and Japanese honeysuckle. They sucker profusely from the roots and must be sprayed several successive years to achieve control.

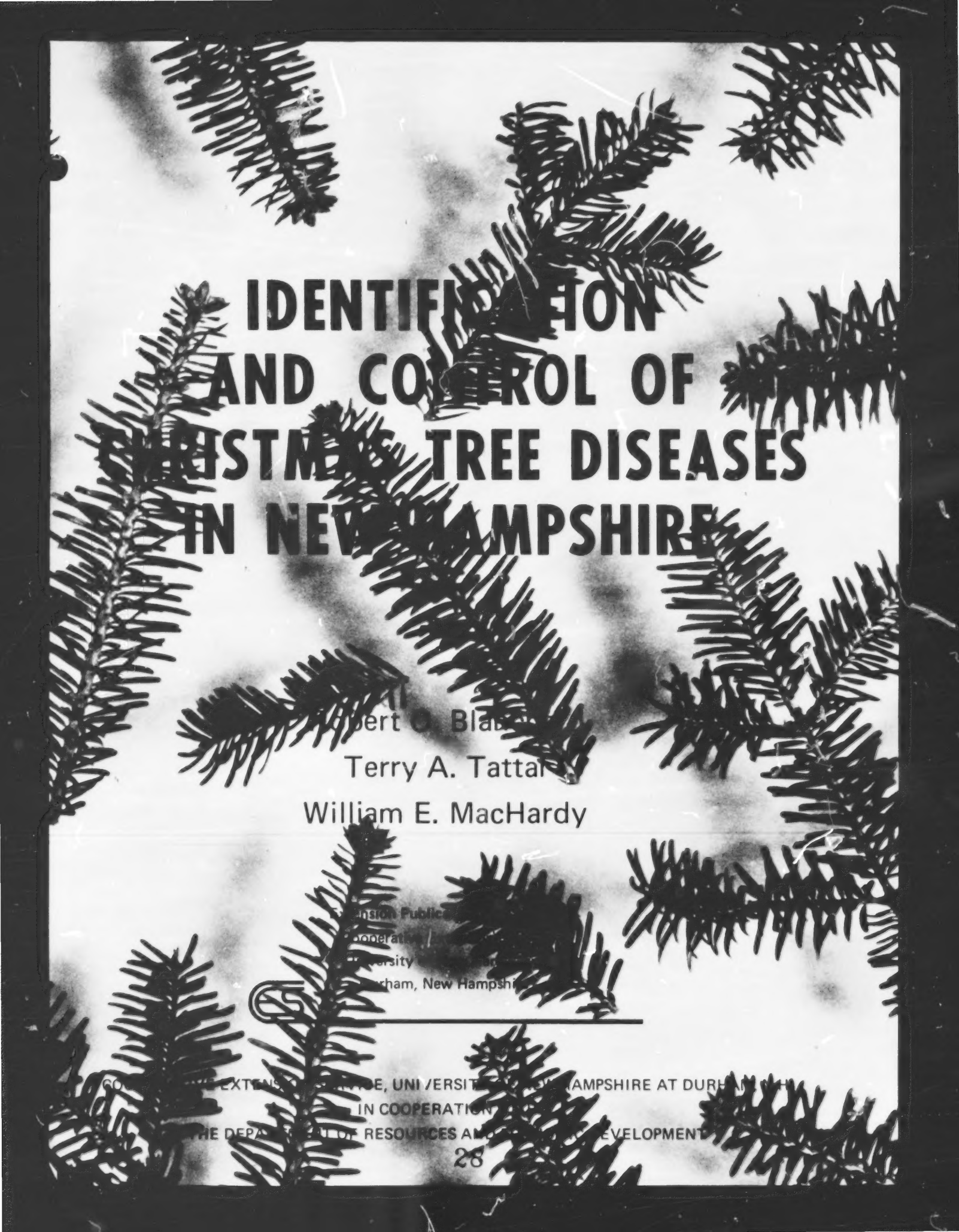
For further information relating to the herbicides mentioned in this section, other materials, or combinations not listed, or on weed problems not described here, contact Extension agents or specialists, or service foresters in your area.

The following table contains current recommendations which conform to existing labels and have proven effective in general use.

CHEMICAL CONTROL OF WEEDS IN CHRISTMAS TREE PLANTATIONS

APPLICATIONS	COMMERCIAL MATERIAL AND RATE	COMMENTS
GRASS AND ANNUAL WEEDS		
1. To control sod and weeds before planting.	Paraquat, 1 qt per acre in 50 to 100 gal water	Apply in October or in the spring after day time temperatures exceed 65° F. Can be used immediately before planting, but must be a separate, directed spray after planting. CAUTION: Paraquat is hazardous to handle. READ the label. TAKE precautions. BE SAFE.
	or	
	Amitrol-T or Cytrol (amitrole) 1 to 2 gal in 100 gal of water	Apply to foliage in October in preparation for spring planting.
2. To control sod and annual weeds just after planting. (see COMMENTS)	Princep 80W (simazine wettable powder), 2 1/2 lb in 25 or more gal water per acre or Princep 4G (simazine granular), 50 lb per acre.	Apply as soon as possible after planting. Use only on 3 year or older seedlings. Do not repeat application the first year.
3. To kill sod and to prevent growth of annual weeds in plantations established 1 or more years.	Princep 80W, 2 1/2 to 5 lb in 25 or more gal water per acre, or Princep 4G, 50 to 100 lb per acre.	Treat in October or early spring. Spring treatment will give longer control of annual weeds than fall treatment. Simazine may be sprayed over the trees. Use only one application per year.
	or	
	Amizine (simazine + amitrole), 7 lb in 50 gal or more of water per acre.	Use directed spray on growing sod and weeds around trees. Avoid contact with stems and foliage.

WARNING! Pesticides are poisonous. Read and follow all directions and safety precautions on labels. Handle carefully and store in original labeled containers out of reach of children, pets, and livestock. Dispose of empty containers right away in a safe manner and place. Do not contaminate food, streams, and ponds.



IDENTIFICATION AND CONTROL OF WESTERN TREE DISEASES IN NEW HAMPSHIRE

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Durham, New Hampshire

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**IDENTIFICATION AND CONTROL
OF
CHRISTMAS TREE DISEASES
IN
NEW HAMPSHIRE**

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**COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF NEW HAMPSHIRE
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IDENTIFICATION AND CONTROL
OF
CHRISTMAS TREE DISEASES
IN
NEW HAMPSHIRE

INTRODUCTION

The rapid expansion of Christmas tree production in New Hampshire has given this agricultural crop status as a significant commercial enterprise. Unfortunately, Christmas trees are affected by the same pathological and environmental conditions that affect most other agricultural crops: weather, site, insects, fungi, bacteria and pollution. Insects and other pest problems have received the most attention in the past* but growers are becoming increasingly aware of the existence and persistence of disease problems. It is the intent of this bulletin to describe the most common diseases affecting Christmas trees in New Hampshire and to indicate the host, causative agents, symptoms and recommended control measures. Non-infectious as well as infectious diseases will be described.

Good Management

Maintaining a profitable Christmas tree plantation requires more than just planting Christmas trees in an

abandoned field and waiting for their maturity. Thoughtful selection of a suitable site with proper soil conditions and water drainage, reduction of competition from other trees, shrubs, grass and weeds, maintenance of soil nutrient levels using acceptable fertilizer and top and side dressings, employment of proven cultural practices and control of insects and other pests are all essential in a well-rounded program designed to prevent the occurrence of plant disease problems.

Frequent inspections for disease symptoms allow for early detection and control of what might be a serious problem. Many disease-causing organisms are opportunists and become serious problems only when predisposing factors weaken trees and decrease their defenses against attack by these organisms. Thus, the conscientious plantation owner is usually not plagued by disease.

*To control insects and other pests of Christmas trees, refer to "Insect, Mite, and Rodent Control in New Hampshire Christmas Tree Plantations", Extension Publication No. 1, published by Cooperative Extension Service, University of New Hampshire.



Symptom on balsam fir of *Uredinopsis mirabilis*. Needles are browned and pustules are evident.



Sensitive fern and balsam fir are alternate hosts of *Uredinopsis mirabilis*, a rust fungus.

DISEASES

I. INFECTIOUS DISEASES—Diseases caused by fungi

A. Needle Casts, Blights, and Molds

Disease	Host	Pathogen	Symptoms	Recommended Treatment
Needle cast	Douglas fir	<i>Rhabdocline pseudotsugae</i>	In the fall, minute yellow spots appear on both surfaces of current needles. The following spring, spots are larger, mottled and red-brown. By early summer, fruiting structures appear on each side of the midrib on the lower surface of needles. Majority of needles fall and by late summer foliage is sparse.	Locate plantations on sites with good air drainage so that the foliage will dry quickly following periods of moisture. Copper fungicides are often recommended if symptoms are sufficiently severe to require control.
Needle cast	Douglas fir	<i>Adelopus gaumanni</i>	Very similar to <i>Rhabdocline</i> needle cast. Both may be present on the same tree.	" " "
Needle cast	Balsam fir	<i>Bifusella faullii</i>	Two-year-old needles turn light brown with labyrinth-like brown pycnidia forming along the groove on the upper surface. Elongated brown ascocarps are formed on the lower surface of 3-year-old needles.	" " "
Needle cast	Balsam fir	<i>Hypodermella nervata</i>	Black pycnidia form 2 lines, one on each side of groove on upper surface of second-year needles. Ascocarps form along groove on lower surface of 3-year-old needles.	" " "
Needle cast	Scotch pine	<i>Lophodermium pinastri</i>	Tiny spots with brown centers and yellow margins appear in early spring followed by yellowing then browning of needles; the degree of browning increases from top to bottom of tree. Tiny black fruiting bodies appear on dead needles. They are football-shaped, protruding, on both surfaces of the needle and are slit down the middle.	Where disease has been severe, spray with maneb plus zinc fungicide (Manate D or Dithane M-22 special) at the rate of 1½ lb. per 100 gal. of spray. First spray at end of July or early August, two additional sprays at 14-day intervals. Use spreader-sticker. Daconil has been used recently with good success.

Disease	Host	Pathogen	Symptoms	Recommended Treatment
Needle cast (Brown spot)	Scotch pine	<i>Scirrhia acicola</i>	Tiny spots with brown centers and yellow margins appear in late summer. In the fall the needles turn yellow, then brown; browning usually confined to lower half of tree. Tiny black fruiting bodies appear on dead needles. They are irregularly-shaped and flush with both surfaces of the needle.	One spraying of Bordeaux mixture when needles are about half grown. In severely infected plantations a second spraying may be needed after needles are completely elongated. (mixture of 8-8-100 with hydraulic sprayer; 24-24-100 with mist-blower)
Tip Blight	Scotch pine	<i>Diplodia pineae</i>	Dieback of current season's growth which, if repeated, results in stunting. Needles turn brown and terminal buds exude excessive amounts of resin. Bark may turn deep red with black streaks in the wood.	1. Remove and destroy all affected twigs. 2. Spray with Bordeaux (8-8-100, if available) or fixed copper as soon as new growth is half grown, and about 14 days later. 3. In rainy springs, a 4th application 10 days after the third may be necessary. 4. Use spreader-sticker. 5. Fertilize trees in fall or early spring.
Tip Blight	Balsam fir	<i>Rehmiellopsis balsameae</i>	Yellowing, shriveling and curling of current needles and dying back of young twigs.	" " "
Tip Blight	Spruce (white and blue)	<i>Ascochyta piniperda</i>	Darkening, browning and eventual dropping of young needles, with drooping shoot tips. Bent tips often bear needles on which pycnidia form.	" " "
Snow Blight	All conifers	<i>Phacidium spp.</i>	Foliage beneath snow turns brown as snow melts, white mycelium can be seen on browned needles.	Spray lowest branches with lime-sulfur (1:8, if available) or fixed copper in late fall. Plant in fertile soil.
Sooty mold	All conifers	<i>Ascomycetous fungi in family Perisporiaceae</i>	A sooty growth or crust in isolated patches or covering entire needles. Mold fungus develops on honeydew excreted by insects. No apparent injury.	Control the insects responsible for secreting the honeydew on which the fungus exists.

B. Rusts—This group of obligate parasites is commonly encountered but usually causes little damage. Most of the common rusts of Christmas trees listed below are heteroecious (occur on two hosts). In the absence of one of these two hosts, the life cycle of the fungus is interrupted. Therefore, removal of the alternate hosts near the plantation is recommended as the best method of control in cases where rusts cause damage.

Disease	Host	Alternate host	Pathogen	Symptoms
Fir-broom Rust	Balsam fir	Chickweed (<i>Cerastii</i> spp.)	<i>Melampsorella cerastii</i>	Witches' brooms with dwarfed and yellowish needles. Two rows of orange-yellow pustules on lower needle. Needles shrivel and drop.
Fir-huckleberry Rust	Balsam fir	Blueberry (<i>Vaccinium</i> spp.)	<i>Pucciniastrum geoppertianum</i>	White-yellow pustules on lower surface of current needles.
Fir-fern Rust	Balsam fir	Sensitive fern (<i>Onoclea sensibilis</i>)	<i>Uredinopsis mirabilis</i>	White, cylindric pustules on lower surface of current needles. Needles turn brown.
Needle Blister Rust	Scotch pine	Aster (<i>Aster</i> spp.) Goldenrod (<i>Solidago</i> spp.)	<i>Coleosporium asterum</i>	Conspicuous white pustules (up to 1/8" high) on older needles. Trees are not usually killed, but retardation in height growth may result.
Sweetfern Blister Rust	Scotch pine	Sweetfern (<i>Comptonia perigina</i>)	<i>Cronartium comptoniae</i>	Orange pustules on stem or on twig galls. Most damaging by its girdling action. After a tree reaches basal diameter of about 3 inches, it is relatively safe.
Eastern Gall Rust	Scotch pine	Oak (<i>Quercus</i> spp.)	<i>Cronartium quercum</i>	Knotty galls on stems or trunks.
Comandra Blister Rust	Scotch pine	Bastard toad flax (<i>Comandra</i> spp.)	<i>Cronartium comandre</i>	Spindle-shaped swellings on branches and trunks.
Spruce Needle Rust	Spruce (white and blue)	Labrador tea (<i>Ledum</i> spp.)	<i>Chrysomyxa</i> spp.	Whitish blisters on lower surface of 1-year needles. Needles turn yellow and may drop prematurely.

C. Root Rots

Disease	Host	Pathogen	Symptoms	Recommended Treatment
Armillaria root rot	All species	<i>Armillaria mellea</i> (Honey mushroom)	Tree mortality is associated with decayed roots. White fungus mats appear under the bark of roots. Fruiting structures develop in clusters on stumps, at the base or on the butt of dead and dying trees, or on the ground coming up from infected roots.	Root rot diseases are not usually a serious problem in Christmas tree plantations but if found there is an indication of other problems such as improper planting. Maintain tree vigor and avoid poor growing sites.
Fomes root and butt rot	All species (mostly pines)	<i>Fomes annosus</i>	The presence of a bracket fungus fruiting at the base of the trunk and often beneath the duff usually indicates that the tree is infected.	

II. NON-INFECTIOUS DISEASES—Diseases not caused by any living pathogens. All Christmas tree species are susceptible.

Disease	Symptoms	Recommended Control
Winter injury	Reddening and browning of the past year's foliage during winter and spring. The entire tree is generally affected. Spruce is the most susceptible.	Avoid sensitive species in exposed locations.
Frost injury	New foliage shows browning by late spring. Damage is most severe on lower branches but may be all over the tree.	Avoid planting in known frost pockets.
Nutritional disorders	Foliage yellow and stunted. Not related to any of the other problems discussed. If severe, needles may turn brown and die. Shoots die back.	Good knowledge of soil fertility and regular program of balanced soil fertilization. Have soil tested.
Sunscorch and wind burn	Dry, windy and extremely warm weather and insufficient soil moisture cause water to be lost faster than it is supplied from the roots. Needles die back; trees look scorched.	Avoid planting in exposed areas that have limited soil moisture.

Disease**Symptoms****Recommended Control**

Adverse site factors

Trees in poor vigor in certain locations in the plantation.

Avoid planting in frost pockets, shallow soil, extreme exposure and areas with extremes of soil moisture. Most non-infectious diseases can be avoided by avoiding adverse site factors.

People pressure diseases—

These non-infectious diseases of Christmas trees are related to the activities of man. Symptoms are variable. Diagnoses are best made through association of known causes.

Air pollution

Symptoms vary depending upon the type of pollutant. Dwarfing of needles and yellowing or browning of tips of entire fascicles and groups of fascicles are common.

Trees growing near heavy industrial operations or major highways may be exposed to toxic air pollutants. Learn the possible sources of toxic air pollutants that are being produced near the trees. Air pollution is difficult to control without a community effort.

Salt injury

Moderate to severe tip burn and dwarfing of needles. Balsam fir particularly susceptible.

Avoid planting near heavily-salted roads.

Planting injury

Poor vigor.

Avoid planting too shallow or too deep. Root rots are often associated with poorly-planted trees.

Mechanical injury

Open wounds resulting from careless use of cultivation equipment or any mechanized equipment near trees.

Avoid improper spacing of rows or erratic planting within rows. Use mechanized equipment carefully around trees.

Pesticide and Fertilizer injury

Needle burn if direct contact is made. Yellowing of needle tips if translocated from roots.

Proper use of all agricultural chemicals (pesticides and fertilizers) and strict adherence to recommendations given on the label.

GLOSSARY

Ascocarp—a fruiting body of the Ascomycetes, frequently globose, flask-like or cup-like.

Blight—common name for a number of different diseases of plants, especially when leaf damage is sudden and serious.

Bordeaux mixture—fungicide composed of copper sulfate, hydrated lime and water. It is still available but often difficult to obtain.

Dieback—dying of shoots from tip back.

Fascicle—a little group or bundle.

Fungus—plants with no vascular or water-conducting system and no chlorophyll, and which live on other living organisms or their residues.

Fruiting body—fungus structure within which spores are formed.

Gall—a swelling or outgrowth produced by a plant as the result of attack by a fungus or other agent.

Infectious Disease—diseases caused by living organisms such as fungi and bacteria.

Mycelium—a mass of thread-like filaments which makes up the body of a fungus.

Non-infectious Diseases—diseases not caused by any living organism and not spread from tree to tree.

Pathogen—generally any organism that can cause disease in a particular host.

Pustule—a blister-like spot or spore-mass.

Pycnidium—a fruiting body of the Sphaeropsidales (Fungi Imperfecti); frequently globose or flask-like.

Spreader-sticker—material added to a spray preparation to improve contact between the chemical and plant surface and to increase adhesiveness.

Witches' broom—Massed outgrowths of the branches of woody plants, caused most often by rust fungi.

CHRISTMAS TREE PLANT DISEASE IDENTIFICATION FORM*

DIAGNOSING DISEASE PROBLEMS

The cause of many Christmas tree diseases can be determined by referring to this bulletin. But it is not always possible for a plantation owner to know for sure why his trees are showing symptoms of disease. One reason is that any one of several different kinds of agents (insects, fungi, bacteria, physiological imbalances or unfavorable environmental conditions) may cause the appearance of the same symptoms. Also, peculiar growths may appear on the needles, twigs or trunk. These growths are actually structures belonging to a fungus causing the disease, but they are unfamiliar and confusing to the plantation owner.

Since a correct diagnosis is essential before control measures can be suggested, one must, in these instances, request the assistance of a specialist such as the county forester or county agricultural agent. Listed below is the procedure one should follow when submitting specimens for disease diagnosis.

HOW TO COLLECT AND SEND SPECIMENS FOR DISEASE DIAGNOSIS

A diagnosis can be only as good as the specimen you send. Adherence to the following is necessary for a fast, accurate diagnosis.

1. Complete the PLANT DISEASE IDENTIFICATION FORM. The completed form *must* be included with the plant specimens.

2. Carefully examine all parts (needles, branches, trunk and exposed roots). Take time to select representative samples from all parts displaying symptoms or fungal growths.

GENERAL INFORMATION:

Grower Telephone No.
Address Zip Code
Name of tree attacked Approx. percentage of plantation affected
Has trouble appeared in previous years? () Yes () No If yes, how long?
Date sample collected

SYMPTOMS:

When were symptoms first noticed?
Is there evidence of mechanical injury due to storms, machinery, heavy pruning, faulty transplanting, animals, etc.? () Yes () No.
If yes, describe.....
Could winter injury account for the symptoms? () Yes () No. If yes, explain
Are fungus-like growths, insects or peculiar growths present on the tree? () Yes () No. If yes, describe
Carefully observe needles, twigs, trunk and exposed roots and *clearly* describe all symptoms

Specialist
Date Rec'd
Date Ans'd

Do not write in this space.

3. Send *generous amounts* of material.

4. Generally, specimens showing early stages of symptom expression are best for diagnostic purposes. However, you may also want to include specimens having more advanced symptoms. It is often helpful to include healthy specimens for comparison.

5. All specimens should be *fresh* when collected.

6. If roots are collected, they should be free of soil and wrapped in a *slightly* moist paper towel.

7. It is advisable to wrap the ends of cut stems as in No. 6.

8. *Never* mix samples from different kinds of trees in the same bag.

9. If a general decline or dying of trees is observed, send a) generous samples of all above-ground portions showing early and moderate symptoms; b) at least a pint of soil; c) a good handful of feeder roots.

10. Place fresh specimens in a plastic bag. Punch a few holes in the bag to allow for air exchange.

11. *Never* add water to any sample.

12. Protect specimens from being crushed in the mail. Place plastic bag(s) in a cardboard carton and pack with crumpled paper or other suitable material.

13. Mail or carry *immediately* to a specialist.

IMPORTANT REMINDER: Dead plants, material that is dry or decomposing on arrival, and specimens arriving without necessary information **CANNOT BE DIAGNOSED.**

List all fertilizers, fungicides, insecticides, herbicides, top and side dressings, etc. applied during the current growing season.

[illegible]

SOIL:	<u>Type</u>	<u>Terrain</u>	<u>Drainage</u>	Have soil nutrients and pH been analyzed?
()	Sandy	() Sloped	() Good	() Yes () No
()	Clay	() Level	() Moderate	If yes, when?
()	Loam	() Low	() Poor	Significant results:

Have there been any disturbances to the soil recently?

Any significant weather conditions within the past week or two which may account for the problem?

Have pesticides, herbicides, etc. been used by others near-by (including roadside or power-line sprays)?

.....

Please add any additional comments you feel may relate to the problem.

Carefully check all questions that apply to make certain they have been answered: You could easily miss the important one! Enclose with plant specimens and mail or carry *immediately* to a specialist of your choice.

Allow up to two weeks for a reply

Do not write below this line

DIAGNOSIS:	Non-infectious	Infectious
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Name of disease

Causal agent

Additional comments and control recommendations

*This form may be obtained from County Cooperative Extension Service offices in Brentwood, Claremont, Concord, Conway, Keene, Laconia, Lancaster, Milford, Dover, and Woodsville.

INSECT PESTS OF CHRISTMAS TREES

Balsam Fir Sawfly

Neodiprion abietis

Balsam fir is the preferred host of this sawfly, but it has also been recorded on black and white spruce.

Overwintering occurs in the egg stage in slits on the edges of the fir needles. Hatching occurs in May or June depending upon weather conditions. Old needles are fed upon by the developing larvae. These larvae mature in about one month. When fully mature, they spin a cocoon in the trash on the ground or among the needles. Adults emerge in late July through early September. Mating and egg ovipositing then occurs.

European Pine Shoot Moth

Rhyacionia buoliana

Small (1/5 inch), dark brown larvae with black heads overwinter inside buds or under masses of pitch on the buds. The caterpillars become active in late April and bore into another bud. When they reach maturity in late May or early June, their length is approximately 5/8 inch. They pupate inside their resinous burrows, and the moths emerge from mid- to late-June. The moths have coppery-orange front wings marked with several silvery lines. The rear wings are gray. The wing expanse is about 3/4 inch.

Eggs are deposited on the needles, buds, and twigs in late June to mid-July. The larvae first bore into the base of needles, but by August, they move to the buds to feed and to prepare an overwintering site.

The insect attacks most species of pines. Red pine and mugho pine are often severely damaged. The greatest damage results from the feeding of the caterpillars in the spring. Killed buds result in dead tops and forked and bent stems--in general, trees of little value.

Cutting out and destroying infested buds before mid-June is of some value in reducing the number of moths that would normally emerge. This insect is not a problem where temperatures fall below 20°F during the winter months.

Nantucket Pine Tip Moth

Rhyacionia frustrana frustrana

Damage done by this species is similar to that of the European pine shoot moth. Its preferred host trees in this area are Scotch, pitch and Virginia pines. It does not attack white pine or the long-needle pines.

One generation is present each year in New Hampshire. The insect passes the winter as pupae in the damaged shoots. The adult moths emerge in late May and early July and deposit eggs on the needles.

The moths are predominately brick-red with some gray; they have a wing expanse of about 1/2 inch. The larvae are cream to light brown and slightly longer than 1/4 inch when fully grown. There is one generation known per year in New Hampshire.

First evidence of larvae are small, fragile, webs constructed in the axil of a needle sheath and stem. Later, webbing mixed with resin will be seen at the tip of the shoot. Infested shoots often die and turn brown. The principle difference between the damage of the Nantucket and the European moth is that the latter attacks the buds, and the Nantucket attacks mainly the tips of the shoots.

Gypsy Moth

Porthetria dispar

Gypsy moths overwinter in the egg stage. Small, dark, hairy caterpillars start hatching about May 1. They prefer oak and other broadleaf trees and feed on those for a short time. The newly hatched larvae do not prefer evergreens but will readily feed on them after the insects have gone through their first molt. The caterpillars reach maturity from mid- to late June when their length is approximately two inches. They pupate on tree trunks and other stationary objects. Moths appear in early July. The female moths are heavy-bodied, and white with black dots along the tips of the wings. They do not fly. Male moths are brown and are active all day and at night. There is only one generation per year. This insect is not a real pest of Christmas trees, but rather that of regulatory concern.

Mites

The spruce mite and red mite are tiny (barely visible), yellowish to red, spider-like insects. They prefer spruce and are seldom a problem on pine or fir. The mites extract sap from the needles. Affected needles have a faded, grayish appearance which eventually turns to a coppery-green. Badly damaged needles will drop prematurely.

A second type of mite, Eriophyid, is too small to see without magnification. They are creamy-white and elongate--almost worm-like. They are found on Scotch, Austrian, mugho, and white pines. They feed inside the needle sheath. First symptoms are stunting of needles on new growth. Tips of needles may be twisted; needles may turn yellow, then brown, and then may drop off.

Northern Pine Weevil

Pissodes approximatus hopkins

Adult weevils are about 1/4 inch long and brown with white spots toward the rear of the back. The mouth parts form a beak. The larvae are white, legless, fleshy grubs that are slightly longer than 1/4 inch when fully grown. The adult weevils and the grubs are almost identical in size and appearance to the white pine weevil, but the life cycle of the two species is quite different.

Northern pine weevils go through the winter as larvae, pupae or adults, hibernating in the duff under the trees. They emerge in late March and April and deposit eggs in freshly cut pine stumps, in slashings, and sometimes in spruce and fir stumps and cut limbs. Grubs mature in July.

Extensive feeding results in girdling of branches or seedlings which eventually die. Typical injury is scattered brown branches throughout the infested trees.

Since the larvae develop in stumps and large cut limbs, all slashings should be removed from the plantation and burned. If possible, allow stumps to rot away for at least one year before replanting the same area.

Pales Weevil

Hylobius pales

The damage caused by this species is similar to that of the northern pine weevil. The adult weevils are dark reddish-brown to almost black. They are slightly larger than the northern pine weevil (about 3/8 inch). In Christmas tree plantations, practically all larval development has been observed in freshly cut stumps near or below ground level.

Preferred host trees are Scotch, white, and red pines, and Douglas fir. The adult weevils will also attack spruce, especially seedlings.

Cultural control measures are the same as those for the northern pine weevil.

Pine Spittle Bug

Aphrophora parallela

The white spittle masses in which the slimy, brown nymphs feed are conspicuous, but damage to trees is minor. The nymphs hatch in May from eggs that were deposited on the bark the previous summer. The feeding nymphs extract juices from the twigs; when the nymph population is high, the trunk and limbs remain wet with spittle. Heavy feeding causes some stunting of new growth, and limbs and twigs often become blackened from a sooty fungus and dirt that collects on the wet bark.

The dark-brown to black adult spittle bugs are about 3/8 inch long, plump, and tapered at both ends. They are present during late July and August. It appears that they do not feed. Pine spittle masses may appear on all Christmas tree species, but Scotch pine seems to be the preferred host.

Pine Webworm

Tetralopha robustella zeller

The major damage inflicted by this pest is to young trees during their first five years. The pine webworm prefers pitch and jack pine, but will attack Scotch, red, and white pines as well.

The insect passes the winter in the pupal stage in the soil under trees. The adult moths are present from June to August. They have a wingspread of approximately one inch, with forewings that are mostly black. They deposit their eggs on pine needles. In late July, early August, small larvae first mine the needles, but as they develop, they live in silken tubes surrounded by masses of brown granular frass (excrement). The clumps of frass webbed in the ends of the branches is the typical symptom of webworm damage. Pine webworm larvae are yellowish-brown with a narrow dark stripe along each side of the back. When the larvae reach full size in late summer, they are approximately 3/4 inch long.

Pine Needle Scale

Chionaspis pinifoliae

Very light infestations of this scale show up as scattered white spots on the needles, but moderate to severe infestations will cause yellowish to brownish discoloration of the needles and death to the trees. This scale attacks all species of pines grown for Christmas trees and may also be found on spruce and Douglas fir.

Both the female and male are white. The female scales are approximately 1/8 inch long; the male scales are slender and much smaller than the females. Heavily encrusted needles will be practically white covered with the bodies of these insects.

Under the dead body of the female scale, purplish eggs pass the winter. Each cluster normally contains 20 to 30 eggs. The eggs begin to hatch about mid-May, and hatching is virtually completed by early June. The tiny nymphs, or "crawlers," are pale yellow. This is the mobile stage of the insect; their mobility is limited to only a few inches from their origin unless they are carried by the wind or picked up on the bodies of birds or other insects. Crawlers move on the needles until they find a suitable site to insert their sucking mouthparts. Within a week after attachment to the needles, the legs of the nymphs degenerate and disappear, and the hard scale covering starts to form. There is most likely one generation per year in New Hampshire with only a partial second, if any.

An efficient predator of pine needle scale is the twice-stabbed lady beetle, a small black beetle with two red spots on the back. This insect may be seen in the trees from early spring to late fall feeding on the eggs and other stages of the scale.

Sawflies

At least a half-dozen different species of sawflies attack Christmas trees; the two most common and abundant are the European pine sawfly and the red-headed pine sawfly. The larvae of both species eat the needles, causing partial to complete defoliation of the infested trees.

European Pine Sawfly - This is an early spring feeder. The larvae hatch from the overwintered eggs in late April and early May. The larvae are olive green and have wrinkled skin with a narrow, pale-white stripe along the center of the back and a narrow black stripe along each side. In early June, the larvae are 3/4 to one inch long. They drop to the ground and form chocolate-brown, hard-shelled, smooth cocoons. Adult sawflies emerge in late August and September and deposit eggs in slits along the edges of selected needles. This sawfly produces one generation each year.

The larvae feed on the one- and two-year-old needles of Scotch, jack, and red pines. They will sometimes feed on Austrian, white, and mugho pines, but do not prefer them.

Red-Headed Pine Sawfly - Larvae of this species usually do not appear until late May, but some are likely to be present throughout the summer. The larvae are white to yellowish with pale red heads. As the larvae reach maturity, they are about one inch long and are covered with black spots. They pass the winter in pupal cells in the duff and soil below the trees. Adult sawflies start emerging in May and continue to emerge over a period of several months. Eggs are deposited on one-year-old needles.

The larvae feed in groups starting at the tip of a branch and work downward, causing defoliation as they go. Favorite host trees are jack, red, Scotch, mugho, and Austrian pines. The larvae may occasionally be found on white pine and Norway spruce.

General infestation of an entire plantation is rare. Normally, a few trees are infested, and spot treatment of the few infested trees is usually adequate to prevent serious defoliation.

Spruce Budworm

Choristoneura fumiferana

The spruce budworm prefers balsam fir, spruce, and hemlock, but will also feed on larch and pine.

Spruce budworms pass the winter as small larvae inside small silken cases stuck to twigs of the tree. They start feeding in the spring before the buds expand. They bore into needles and developing buds. Later, they feed on developing shoots and new foliage. The larvae reach maturity in late June and July. They are about 7/8 inch long and have a reddish-brown body with prominent, small yellow warts on each body segment. They pupate within webbed needles on the tree.

The adult moths appear during July. They are mostly gray with yellowish-orange markings, and have a wingspread of about one inch. The tiny, light-green, flat eggs are deposited in elongate masses on the needles with eggs overlapping in a shingle-like fashion. The young larvae hatch in August and soon prepare thin silken cases for overwintering. One generation is produced each year.

Spruce Gall Aphids

Two species of aphids are responsible for the formation of galls (distorted swellings) on new growth of spruce.

Cooley Spruce Gall Aphid - This aphid attacks Colorado blue, white, Sitka, and Engelmann spruce. It also attacks Douglas fir, but the feeding on fir results in twisted and curled needles instead of galls.

The insect passes the winter as a partially grown nymph attached to a twig near the base of a bud. Eggs develop in the overwintered females during late April and early May. The nymphs that hatch from these eggs feed at the base of needles, producing the galls on spruce and causing twisted needles on fir.

The elongate galls are green with a purplish or reddish tint. In July, when the aphids mature and escape, the galls turn brown and unsightly. Several generations are produced each year; aphids move back and forth from spruce to fir.

The spring nymphs that attack the needles of fir produce a white, cottony substance that covers their bodies. Heavily infested fir trees appear to have a light dusting of snow when the aphids are feeding in May.

Eastern Spruce Gall Aphid - The primary host for this species is Norway spruce and occasionally white spruce. The insect passes the winter as an immobile, bluish-black female attached to a twig or bud. Eggs develop in late April and hatch in May when the spruce buds are developing. The feeding by the nymphs results in reddish-green pineapple-shaped galls at the base of the new twigs. In late July and August, the galls break open and the aphids escape. These molt into winged aphids which may fly to other trees or remain on the same tree. The galls soon turn brown. By late September, the overwintering forms have settled on a site to pass the winter. Those that do not select suitable sites will not survive.

A few individual trees in a plantation always are more susceptible than others to attack. It is advisable to remove such highly susceptible trees from the plantation while they are small.

White Pine Weevil

Pissodes strobi

This insect pest has been a limiting factor in the use of white pine for reforestation and for Christmas trees. The weevil is one of the most destructive pest of white pine in New Hampshire; its damage is evident wherever white pine is grown. It will also attack the terminal leaders of Norway spruce, and a few infestations have been recorded on Scotch pine.

The insect overwinters as an adult weevil, about 1/4 inch long, with a brown body with white patches near the rear end of the back. Their mouthparts protrude to form a short snout. The adults emerge after a few warm days in April and feed on the bark of terminal growth of white pines. At about the time the buds begin to swell, eggs are deposited in the bark on the terminal growth.

The small (1/8 to 1/4 inch), white, fleshy, legless grubs feed on the cambium layer just under the bark. They feed in small groups and work from the top of the leader downward. The girdled leader wilts and dies. Side laterals replace the central leaders, creating a bushy-topped and useless tree.

Larvae mature in late July and August. They pupate near the base of the infested leader, and adult weevils emerge in August. These new adult weevils feed a bit on the bark of the new and old leaders before they hibernate. The feeding of the adults is of minor importance.

The removal of infested terminals by mid-July will help reduce the potential numbers of white pine weevils in areas where white pine is scarce.

European Spruce Sawfly

Gilpinia hercyniae

(Taken from Reprint 34 Society of American Foresters)

History and Distribution: In 1930 the European spruce sawfly was discovered causing serious defoliation of spruce in the Gaspé Peninsula of Canada. The insect apparently became established in North America several decades earlier, for surveys proved that it was present as far south as Pennsylvania and as far west as Ontario. Between 1933 and 1937 heavy infestations developed throughout New Brunswick, west of the Gaspé in Quebec, in northern Maine, and in rather isolated areas in southern Vermont and southern New Hampshire. Considering the outbreak as a whole the peak was reached about 1938. At that time about 12,000 square miles in the Gaspé were heavily infested. Outside of the Gaspé there was little tree mortality, but in that area approximately 10 million cords of spruce were killed, representing about 75 percent of the white spruce and 43 percent of the black spruce. The most important factor responsible for the decline in infestation was a larval disease. In 1938 disease was very common in Vermont and New Hampshire and conspicuous in New Brunswick. By 1940 it was evident in central Gaspé, and had virtually wiped out the Vermont and New Hampshire outbreaks. By 1942 the insect had been reduced to such low numbers over the whole area that it was no longer a serious threat. Fortunately the disease has remained prevalent in light as well as heavily infested stands and, together with several species of introduced parasites which have become widely established, has held the sawfly to a very low level up to the present time (1950).

Host Trees: All species of spruce that occur within the infested area are attacked regardless of age or size. Other conifers are immune.

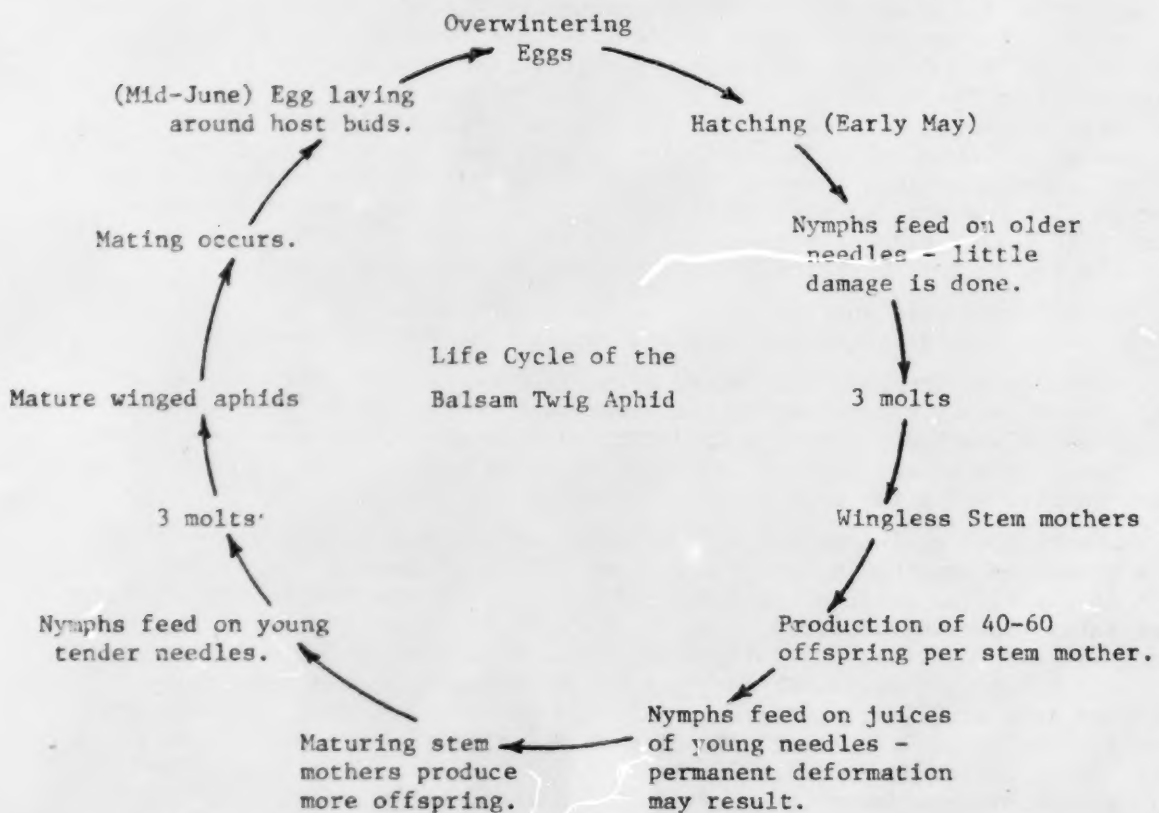
Symptoms of Damage: The larvae first feed on the old foliage, and defoliation is usually heaviest in the lower part of the crown. Larval droppings, which are light green, cylindrical pellets that later turn dark brown, are conspicuous at the base of the tree. Cocoons may be found in mossy places, under sticks, or in the duff on the ground.

Description of Insect and Life History: The spruce sawfly over-winters in a golden to dark-brown cocoon about two-fifths of an inch long which is spun in the litter or moss beneath the trees. Transformation to the adult insect takes place in the spring. Males are very rare, and reproduction takes place without fertilization. The female is a rather stout four-winged fly which is black with yellowish markings on the abdomen, thorax, and head. Eggs are laid singly in slits cut in the old needles, and they hatch in about a week. The young larvae begin feeding at the tips of the needles. At first they are yellowish green and only about one-eighth of an inch long. When nearly full grown they are darker green with five narrow, longitudinal white lines, and they average about four-fifths of an inch long. The body shortens somewhat and the white lines disappear after the larva becomes full fed, and it then drops to the ground and spins its cocoon.

In the Gaspé peninsula one brood of larvae develops annually. However, a high percentage of the cocoons may remain in hibernation 2 or more years before adults emerge. In Maine and New Hampshire there are two broods of larvae each year, and apparently most of the cocoons formed by the second brood produce adults the following spring.

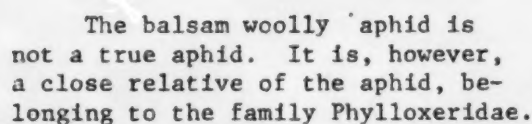
Balsam Twig Aphid
Mindarus abietinus

Balsam fir, white fir and spruce are the preferred hosts of the balsam twig aphid. Feeding is done by piercing the young, tender needles or shoots and removing the juices from within. As a result of feeding, twisted and curled shoots develop and mar the appearance of the young tree.

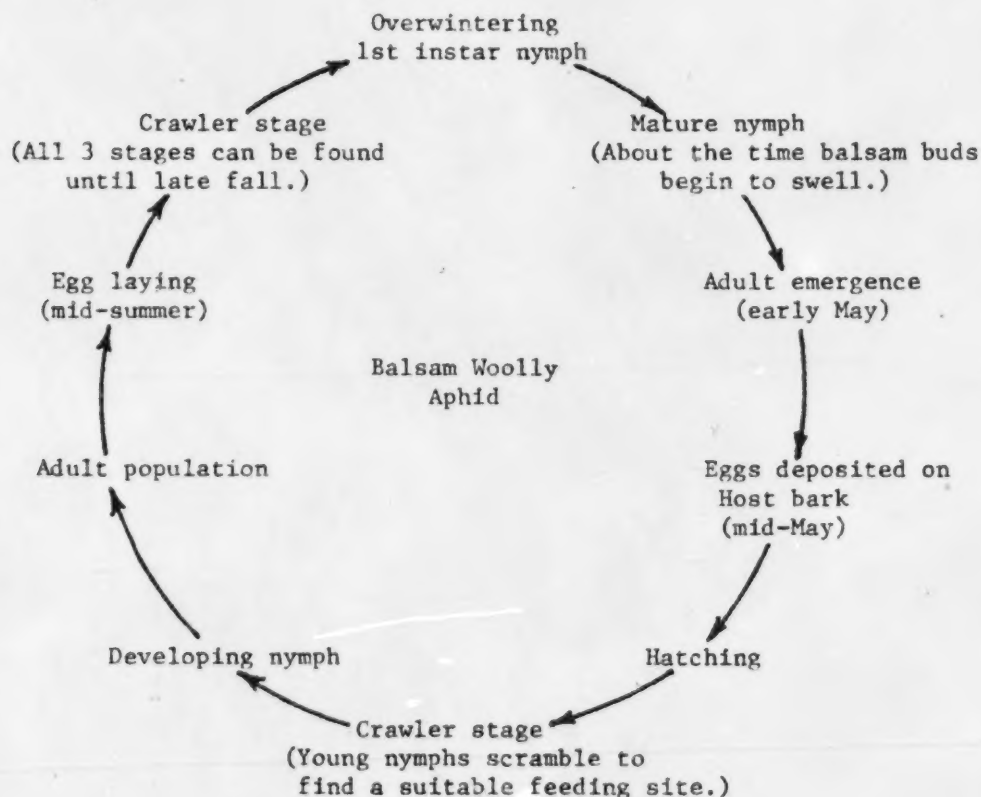


Life Cycle - Balsam Twig Aphid
 2nd Generation is the Peak Generation

Adelges piceae

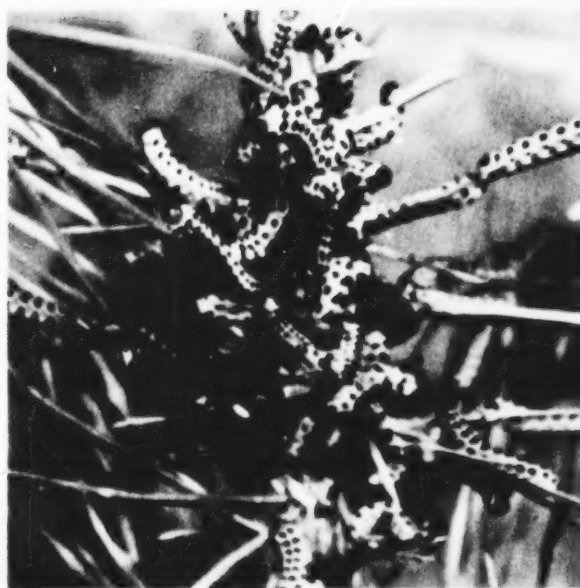


This insect pest feeds on any part of the host (preferably balsam and Fraser fir) that allows it to pierce and remove juices from within (see diagram).



Life Cycle - Balsam Woolly Aphid
2 Generations per year in N.H.

INSECT, MITE, AND RODENT CONTROL
IN
NEW HAMPSHIRE CHRISTMAS TREE
PLANTATIONS



Extension Publication No. 1
COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE

The authors wish to acknowledge the assistance in reviewing this publication of Roger P. Sloan, Extension forester, and Richard J. Nolet, Coos County forester, both of the University of New Hampshire Cooperative Extension Service, in cooperation with the New Hampshire Department of Resources and Economic Development.

Cover shows red-headed pine sawfly larvae feeding on Scotch pine.

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INSECT, MITE, AND RODENT CONTROL
IN
NEW HAMPSHIRE CHRISTMAS TREE
PLANTATIONS

by

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in cooperation with the

N. H. DEPARTMENT OF AGRICULTURE,
DIVISION OF INSECT AND PLANT DISEASE SUPPRESSION AND CONTROL

Introduction

Christmas Tree Production

New Hampshire conditions are ideal for the commercial production of Christmas trees. As this form of agriculture has grown, it has become more obvious that a set of recommendations for the control of Christmas tree insect pests and spraying techniques is necessary. This is the primary purpose of this bulletin.

Pesticides and the Woodland Environment

The very location of most Christmas tree plantations presents a possible contamination hazard to bordering woodlands through use of pesticides. For this reason, extreme care should always be utilized in spraying in and around woodlands in New Hampshire. The materials recommended in this bulletin are for the most part safe to use when directions are strictly followed. The biggest factor to consider when using power equipment is wind-caused drift. This is also true when tree plantations are bordering fields used in vegetable or forage feed production. Several of the recommended pesticides in this bulletin are definitely not registered for use on edible agricultural or forage crops. Extreme care must be taken when these are used in areas where these are grown. Relative mammalian toxicities of common Christmas tree pesticides are given in Table 3. Be sure to read the warning label on container. For additional information one should contact the county forester at the Cooperative Extension Service office in his county.

Timing of Pesticide Applications

The use of specific pesticides to control specific Christmas tree pests is usually recommended in this bulletin on a strict time-oriented schedule for New Hampshire conditions. Such treatments should be applied as close as possible to the given time period indicated. These time schedules are arranged to take advantage of each pest's life cycle. If a pesticide is applied too early or too late it may miss this susceptible stage and be ineffective.

Nutrition, Varieties and Soil Types

These are all extremely important limiting factors in commercial Christmas tree enterprises. The Christmas tree producer should consult his county forester concerning these factors as well as proper elevation, site and proper cultural methods required for maximum protection. Agriculture is a scientific process that must be followed in a scientific way for best results.

Pesticide Dilution and Application

Pesticides recommended in this bulletin are listed below in Table I. Their dilution rates are given for 100 gallons and 1 gallon water mixtures. These dilution rates are based on the manufacturers' and U.S. Department of Agriculture's research findings and must be followed exactly. Overdosing is valueless in insect control and it may lead to cross-contamination and wildlife injury. Dusting with dry powders is not recommended for Christmas tree insect control.

How Much Insecticide to Buy:

The amount of chemical needed will depend on the number of trees in the plantation and the size of the trees to be treated. To get an estimate of the amount of chemical you needed to treat the plantation, spray 10 trees of an average height with the spray unit intended to be used with water. Spray as though the trees were being treated with an insecticide covering the upper and lower surfaces of all needles. Determine the amount of water used and divide by 10 to get the amount of water used to treat a single tree. This amount corresponds to the amount of solution that is needed to treat each tree. How much insecticide to buy equals

$$\frac{\text{Amt. water/tree} \times \text{No. trees}}{100} \times \text{Dil. Rate/100 Gal.}$$

EXAMPLE: In treating the 1,000-tree Christmas tree plantation, for Eastern Spruce Gall Aphid, Malathion may be used —

With a knapsack sprayer, treat 10 average size trees in the plantation. Three gallons of water were used. To convert to the amount of water used per tree, divide the 3 gallons by 10.

$$\frac{3 \text{ Gallons}}{10} = .3 \text{ Gallons}$$

Now to determine how much chemical to buy, use the formula

$$\frac{\text{Amt. water/tree} \times \text{No. trees}}{100} \times \text{Dil. Rate/100 Gal.}$$

(See Table 1. Page 3)

$$\frac{3 \text{ Gal} \times 1000}{100} \times 1 \text{ qt.} = 3 \text{ qts. Malathion EC}$$

EQUIPMENT NEEDED:

For the average New Hampshire Christmas tree producer, the hand type compression sprayer is the most practical method of applying insecticides. These sprayers range in size from 2½ gallons to 5 gallons capacity and come with an adjustable nozzle. For the larger producer, the motorized compression sprayer or mist blower may be more practical.

Pesticide Dilutions

The pesticide materials recommended in this bulletin for controlling pests of Christmas tree plantings should be diluted in water as follows:

Table 1. Pesticide Formulations and Dilution Rates†

Material	Formulation	Amounts to Add to 100 Gallons Water	1 Gallon Water
Malathion	57% EC ¹	1 qt.	2 teaspoons*
Malathion	25% WP ²	1 lb.	1 tablespoon*
Lindane	25% WP	4 oz.	1 tablespoon
Lindane	20% EC	1 qt.	2 teaspoons
Sevin	50% WP	2 lb.	2 tablespoons
Sevin	80% WP	1¼ lb.	1¼ tablespoons
Methoxychlor	50% WP	2 lb.	2 tablespoons
Methoxychlor	20% EMS ³	2 qt.	4 teaspoons
Kelthane	35% WP	1 lb.	1 tablespoon
Kelthane	18.5% WP	2 lb.	2 tablespoons
Cygon	23% EC	1 qt.	2 teaspoons
Thiodan	50% WP	1½ lbs.	1½ tablespoons
Chlordane	45% EMS	1 qt.	2 teaspoons

* Level spoonful.

† Mist blower requires greater concentration. See table No. 3.

1. Emulsifiable concentrate

2. Wettable powder

3. Emulsion

Mouse Control

Field mice feed on the bark around the base of the conifer trunks. Mouse runways and fine tooth marks on the bark and wood are symptoms of mouse activity. Many trees may be killed by girdling. Root pruning may also be a result of field mouse damage. The most severe damage is done in the winter months when other food sources are scarce.

I. CULTURAL CONTROL

Controlling the weed and field grasses in conifer plantings will greatly reduce rodent damage. A 1½-foot radius around each tree should be kept cleared in all cases for optimum protection. Even in closely-cropped areas a thick sod or heavy snow cover may still allow for rodent runways and therefore cultural control may not in all cases be foolproof.

II. CHEMICAL CONTROL

Zinc phosphide apple baits are the most effective means to give chemical control of plantation

rodents. These baits are best applied in the fall before snowfall and after one or two frosts have knocked down most grass cover. During these interim days of Indian Summer, rodent activity is usually greatest. Use one level teaspoon of zinc phosphide for each quart of apples. (Apples should be cut into one-half inch cubes before applying zinc phosphide). Always use fresh bait (within 24 hours of mixing). A one ounce can of zinc phosphide treats about 20 quarts of apples and this makes enough bait to treat three acres. (3 to 4 cubes are placed in runways around each tree). Consult local New Hampshire Fish and Game personnel or Fish and Game Department, Concord, New Hampshire, for details and procedures in applying baits.

Rabbit and Deer Control

Buds and twig tips of young conifers are chewed off during the winter months. Rabbits leave a knife-like angled cut, while deer leave rough and torn twig tips. Control may be effected by applying a commercial deer or rabbit repellent during the fall or early winter periods. A deer repellent can be used if deer are numerous as follows: 1 Pint Arasan 425 plus 1 pint Rhoplex AC 33 to 2 pints water; apply in fall.

Frost Injury

Tender new growth wilts, droops and turns brown following a late spring frost. Avoid planting in low areas; hillsides with good air drainage are preferable. More hardy species such as Fraser Fir, White Spruce, and Scotch Pine should be selected for planting in known frost pocket areas.

Grosbeaks and Squirrel Damage

Pine grosbeaks may in some years cause damage to white pine and balsam fir trees by picking off the terminal bud of both the main leader and lateral branches in the first whorl. There is no known control for grosbeak damage. Squirrels sometimes slice off the tips of Christmas tree branches. It is a clean knife-like cut. If squirrels are numerous in the area, the tips can be treated with a squirrel repellent made up of 1 pint Arasan 425 plus 1 pint Rhoplex AC 33 to 2 pints water; apply in fall.

CHRISTMAS TREE SPRAYING

Calibration of Hydraulic Sprayers

In calibrating the hydraulic sprayer, two basic variables must be considered. They are the pressure and the nozzle orifice size.

First, the plantation owner should determine approximately how much diluted spray is required for the average tree in his plantation.

Recommended test: Treat 10 trees to determine number of gallons of spray used.

$$\text{Gal./Tree} = \frac{\text{Number of Gal. of Spray Used}}{\text{Number of Trees Treated}}$$

then the number of gallons of dilute spray may be figured by knowing how many trees there are per acre of planting.

$$\text{Gal. Needed/Acre} = \frac{\text{Number gallons/Tree} \times \text{Number of Trees/Acre.}}{\text{Number of Trees/Acre.}}$$

Now, knowing how many gallons of dilute spray are required per acre, the producer can utilize his equipment most effectively by determining approximately how many trees he can treat in one minute by using the information received from his equipment dealer giving discharge rates (gallons per minute) per size of nozzle orifice at different pressures. He can regulate his pressure per square inch level and/or his nozzle orifice size to give equal time and coverage for each tree.

Portable Mist-Blower (Airblast) Sprayers

The use of mist-blowers offer some advantages over the use of hydraulic sprayers in control of Christmas tree insects. The main advantage is that less water is needed to apply the required amount of insecticide. Several disadvantages are apparent in that the spray-width coverages is not effective at distances more than 40 feet and that the wind is more of a factor in the effective range of application.

On the negative side, not much is known about the use of mist-blowers in the Christmas tree plantation.

Basically, the principle of the mist-blower is the introduction of the spray material, usually by gravity feed, to a blast of air propelled by a high-speed fan. A higher concentration of spray mixture is used in the mist-blower. In comparison with a dilution rate used in a hydraulic spray two, three, four or more times the amount of chemical is put into 100 gallons of water. While a hydraulic sprayer uses 100 gallons of water or more to an acre, a mist-blower can use as little as 30 gallons per acre.

Wettable powders are not generally recommended for use in a mist-blower. In calculating the dilution rate for a specific insecticide in a mist-blower the following table can be used as a guide.

Table 2. Dilution Table for Mist-Blowers*

If amt./100 gal. to make a dilute spray is:	Emulsifiable concentrate (EC) needed to make a 30X concentrate			
	Use this amount in a mist blower to make a total of:			
	100 gal.	50 gal.	25 gal.	1 gal.
1 pt.	3.75 gal.	1.9 gal.	0.9 gal.	0.6 cup
1 qt.	7.5 gal.	3.75 gal.	1.9 gal.	1.25 cup
2 qts.	15. gal.	7.5 gal.	3.75 gal.	1.25 pt.

* Taken from a publication by the Departments of Entomology and Plant Pathology, Cornell University, *Suggestions for Control of Christmas Tree Pests*, January 1971.

Table 3. LD-50 Values for Insecticides and Acaricides (Lethal Dose)

Label type*	Pesticide	LD-50 mg/Kg white rat	
		Oral	Dermal
C	carbaryl (sevin)	500-850	4,000
W	chlordane	335-430	530
C	chlorobenzilate (Acaraben)	1130	5,000
W	Diazinon	76-108	678
W	dimethoate (Cygon)	215	505
P	Di-Syston	2.3-6.8	11
W	endosulfan (Thiodan)	30-100	45-102
W	ethion	46	154
C	Genite	1,400	NIA**
C	Kelthane	1,000	1,115
W	lindane	88-91	950
C	malathion	1,000-1,375	4,444+
W	Meta-Sytox-R	65-75	250
C	methoxychlor	6,000	6,000
C	Morestan	3,000	500
P	phorate (Thimet)	1.7	4.4
P	phosphamidon	23.5	125
	tetradifon (Tedion)	14,700	10,000+

* C = Caution, W = Warning, P = Poison.

** NIA = No Information Available.

Insects on

Balsam Fir

Balsam Woolly Aphid
Balsam Gall Midge
Balsam Twig Aphid
Fir Tip Mining Sawfly
Spruce Sawfly
White Pine Shoot Borer
Allegheny Mound Ant
Douglas Fir
Cooley Spruce Gall Aphid
White Pine Shoot Borer
Blue Spruce
Cooley Spruce Gall Aphid
White Pine Weevil

Spruces

Eastern Spruce
Gall Aphid
Spruce Needle Miner
Pine Spittlebug
White Pine Weevil
Spruce Mite
Pine Leaf Aphid
Pine Needle Scale
White Pine Weevil
Allegheny Mound Ant
Pales Weevil
Spruce Sawfly

Insects on

Pines

Pine Root Collar Weevil
Pine Bark Aphid
Pine Leaf Aphid
White Pine Aphid
Pine Needle Scale
Pine Spittlebug

White Pine Shoot Borer
Zimmerman Pine Moth
Pine Sawflies
White Pine Weevil
Northern Pine Weevil
Pales Weevil
Allegheny Mound Ant

Christmas Tree Pests of New Hampshire

Insect Pest	Infesting Stage*	Host	Identification and Injury	Treatment†
Pine Bark Aphid <i>Pineus strobi</i>	N&A	Austrian, Scotch and White Pines	Small dark aphids (plant lice) covered with white, flocculent wax. Forms white woolly patches on the trunks, branches, buds and needle bases. The trees become weakened and unsightly if aphids persist.	<u>malathion</u> or <u>lindane</u> . Three applications at 10-day intervals during May and early June. Use a wettable powder formulation and spray under high pressure (100 PSI) to run off. <u>lindane</u> should not be used if cross contamination of forage or vegetables is a factor.
Pine Leaf Aphid <i>Pineus pinifoliae</i>	N&A	White Pine, Red and Black Spruces	These aphids complete a portion of their life cycle on white pine and spruce. Dead and drooping shoots appear on the pine when these aphids are abundant. Feeding by the progeny of spring migrants cause terminal galls on spruces.	<u>malathion</u> WP** as a spray directed to pine foliage in late June and repeated in 10 days. Avoid planting white pine and spruces together.
White Pine Aphid <i>Cinara strobi</i>	N&A	White Pine	Black aphids that feed on twigs and branches. When abundant tree vigor is reduced, severe infestation may kill trees.	<u>malathion</u> WP** as a spray to infested areas. Apply 2 treatments 10 days apart in early May.
Pine Needle Scale <i>Phenacaspis pinifoliae</i>	N&A	White, Red, Scotch, Austrian, Pines and Spruce	Small white scales on needles. Foliage yellows with eventual needle drop. Severe infestation will result in branch or tree mortality.	<u>malathion</u> , <u>dimethoate</u> (<u>Cygon</u>) or <u>carbaryl</u> (<u>Sevin</u>) applied as a foliage spray in mid-May and then 10 days later.
Pine Spittlebug <i>Aphrophora parallela</i>	N&A	White, Red, Scotch Pines and Norway Spruce	Brownish nymphs develop inside white, froth-like, spittle masses that appear at leaf axils, on stems and twig tips. Adults are small, brownish jumping forms that live outside of spittle mass. Tree vigor is reduced by their sucking of sap.	<u>lindane</u> , <u>malathion</u> or <u>carbaryl</u> (<u>Sevin</u>) applied in mid-May. Repeat application in late July if infestation persists.
White Pine Shoot Borer <i>Eucosma gloriola</i>	L	White, Red, Scotch, Austrian Pine and Fir	Small white larvae tunnel out the pith of new growth during June and July. Infested shoots break off and die.	Control is difficult and usually unwarranted. Clip and destroy the infested twigs as soon as symptoms appear.
Zimmerman Pine Moth <i>Dioryctria zimmermani</i>	L	White, Red, Scotch, and Austrian Pines	Whitish or reddish yellow or green larvae with a series of black dots each with a bristle, feeds by mining in branch tips and main stems. Feeding causes growth to be stunted or to die, or may cause the main trunk to be girdled.	Destroy the infested branches or trees. <u>endosulfan</u> (<u>Thiodan</u>) may be used as bark and twig spray in late April or early May. Further applications may be necessary from late June to early August.
Pine Sawflies <i>Diprion</i> , <i>Neodiprion</i> <i>species</i>	L	All pines	Caterpillar-like larvae found feeding in groups or singly particularly on older foliage. Trees defoliated, vigor reduced; severe infestations may kill trees.	<u>methoxychlor</u> or <u>carbaryl</u> (<u>Sevin</u>) sprays applied when larvae are still small in late May or early June. Repeated if necessary.

Christmas Tree Pests of New Hampshire (Continued)

Insect Pest	Infesting Stage*	Host	Identification and Injury	Treatment†
White Pine Weevil <i>Pissodes strobi</i>	L&A	White, Red, Scotch, Pines and Spruce	Adult weevils feed on and deposit eggs in the bark of the leaders. Small curved, white, footless larvae or grubs feed and develop in these leaders. Two and up to four or more years of growth wilt and die.	Spray leaders and upper laterals as buds swell in the spring with <u>lindane</u> . Clip and destroy infested plant parts before July 30.
Northern Pine Weevil <i>Pissodes approximatus</i>	L&A	White, Red, Scotch, and Austrian Pines	Larvae or grubs feed in fresh stumps, slash and weakened trees. Holes through bark are often covered by wood chips. Adults cause damage to healthy trees by feeding on the bark of branches, often girdling them and causing their death.	Burn slash and cull trees maintaining a clean plantation. Drench stumps and ground to a radius of one foot with <u>lindane</u> . Spray as soon as possible in the spring.
Pales Weevil <i>Hylobius pales</i>	L&A	White, Red, Scotch, Austrian Pines and Spruce	Larvae or grubs larger than Northern Pine Weevil but with similar feeding habits.	Same as for Northern Pine Weevil. Seedlings and young twigs can be protected by a <u>lindane</u> spray in April.
Pine Root Collar Weevil <i>Hylobius radialis</i>	L&A	Red and Scotch Pines	Larvae feed in the cambium region around the root collar and may completely girdle the tree just below the surface of the ground. The soil around the root collar is soaked with pitch and blackened by a fungus.	Treat soil and bark at base of tree with <u>lindane</u> . Treat in mid-June and repeat in 10 days.
Balsam Woolly Aphid <i>Chermes picea</i>	N&A	Balsam Fir	This aphid feeds on the trunks and branches and is characterized by a white flocculence. The tips of twigs may show a gouty, swollen condition with a general reduction of tree vigor.	Spray <u>lindane</u> or <u>malathion</u> in early spring just prior to bud break. Be sure to wet the bark thoroughly.
Cooley Spruce Gall Aphid <i>Chermes cooleyi</i>	N&A	Douglas Fir and Blue Spruce	On Blue Spruce the aphids are enclosed in elongate, conelike galls usually at the twig tips. On Douglas fir galls are not formed, but the aphids are characterized by being covered by a white waxy flocculence. Galled and heavily infested twigs become weakened, deformed, or die.	Treat fir with <u>lindane</u> or <u>endosulfan</u> (<i>Thiodan</i>), or <u>malathion</u> , or <u>carbaryl</u> (<i>Sevin</i>) just prior to bud break in the spring. If practical remove galls from spruce before they open in July. Avoid planting Douglas fir and blue spruce in the same plantation.
Balsam Gall Midge <i>Dasineura balsamicola</i>	L	Balsam Fir Fraser Fir	Larvae produce small subglobular swellings at the bases of the needles. During fall most of the infested needles drop. Trees become unsightly with the loss of needles.	Economic control with insecticides is questionable. <u>malathion</u> at a high dosage rate, applied to foliage just as galls begin to swell will reduce the size of the galls.
Eastern Spruce Gall Aphid <i>Chermes abietis</i>	N&A	Norway, Red and White Spruce	Aphids produce pineapple-shaped galls at the base of new twigs. Trees become unsightly with a reduction of vigor. Death of small twigs may occur.	Spray <u>lindane</u> , <u>malathion</u> , <u>endosulfan</u> (<i>Thiodan</i>), or <u>carbaryl</u> (<i>Sevin</i>) just prior to bud break in the spring.

Christmas Tree Pests of New Hampshire (Continued)

Insect Pest	Infesting Stage*	Host	Identification and Injury	Treatment†
Spruce Needle Miner <i>Taniva albolineana</i>	L	All Spruce	Tiny greenish brown, semi-transparent larvae feed within the needles. Groups of dead needles and debris can be found webbed together. Trees become unsightly if enough larvae are present.	Treat foliage with <i>malathion</i> in mid-June and repeat in 10 days.
Spruce Mite <i>Oligonychus ununguis</i>	A&N	All Spruce	Adults and nymphs, both difficult to see without magnification, feed on the needles by piercing them with their mouthparts and sucking the sap. An extremely fine, silken webbing may be found covering the needles. An abundance of mites can cause severe browning and loss of foliage.	Spray thoroughly with <i>Kelthane WP</i> if mites become abundant. Repeat in 10 days if necessary. Wet to run off bark, twigs and needles.
Allegheny Mound Ant <i>Formica exsectoides</i>	A	Pine, Spruce and Fir	Ants inject formic acid into the tissue of the main stem just above the ground. Young trees are killed 20 feet or more from the mounds or nests.	Treat mounds or nests with <i>chlordan</i> .
White Grubs <i>Phyllophaga spp.</i>	L	Pine, Spruce and Fir	Larvae live in the soil and feed on the roots of plants including trees. Feeding can sever or girdle roots causing injury or death.	Treat soil prior to planting with <i>chlordan</i> or after seedlings are set.
Pine Webworm <i>Tetralopha robustella</i>	L	All Pines	Larvae live in silken tubes extending through masses of excrement held together by strands of silk. Young trees become unsightly, weakened and may die when severe defoliation occurs.	Treat with <i>carbaryl</i> (<i>Sevin</i>) when webbing is noticed.
Fir Tip Mining Sawfly <i>Pleuroneura borealis</i>	L	Balsam Fir	Kills tip portion of new growth; damage similar to frost injury. With frost, all of new growth is killed back; with sawfly, only a portion of new growth is killed back.	Control usually not necessary.
Spruce Sawflies <i>Diprion</i> , <i>Pikonema species</i>	L	Spruce	Caterpillar-like larvae often found feeding in groups; feeds primarily on old growth.	<i>methoxychlor</i> or <i>carbaryl</i> (<i>Sevin</i>) sprays when larvae are first seen. Repeat if necessary.
Balsam Twig Aphid <i>Mindarus abietis</i>	N&A	Balsam Fir and Spruce	Feeds on new shoots and needles causing the ends of shoots to twist and the needles to curl.	<i>lindane</i> or <i>malathion</i> spray on warm days in the early spring as soon as buds swell and start to show green.

* Infesting Stages
A = Adult
L = Larvae
N = Nymph
E = Egg

** Wettable power.

† Timing of application is based on an average season in northern or southern New Hampshire. Applications may have to be delayed or advanced by one or two weeks according to seasonal fluctuations and/or location of plantation. See following application timetables. Under the New Hampshire pesticide laws application of certain pesticides has been restricted to licensed commercial applicators and persons holding private applicator permits. Those pesticides underlined in this bulletin are "restricted" in New Hampshire and can be purchased only from licensed pesticide dealers upon presenting a commercial supervisor's license or private applicator's permit number. To obtain a commercial applicator's license or private applicator's permit contact the Office of the Pesticide Inspector, N.H. Department of Agriculture, State House Annex, Concord, N.H. 03301.

APPLICATION TIMETABLE FOR NEW HAMPSHIRE

Insect	March	April	May	June	July	August	September	Insecticide
Pine Bark Aphid			—	—				Malathion, Lindane
Pine Leaf Aphid				—	—			Malathion
White-Pine Aphid			—	—				Malathion
Pine Needle Scale			—	—				Malathion, Carbaryl (Sevin), Dimethoate
Pine Spittlebug			—	—	—			Lindane, Malathion, Carbaryl
White-Pine Shoot Borer			—	—	—			Clip and Destroy Infest Twigs
Zimmerman Pine Moth			—	—	—			Destroy Infested Branches, Endosulfan
Pine Sawflies			—	—	—			Methoxychlor, Carbaryl
White-Pine Weevil		—	—					Lindane, Clip and Destroy Infested Shoots
Northern Pine Weevil	—	—						Lindane
Pales Weevil	—	—						Lindane
Pine Root Collar Weevil				—	—			Lindane
Balsam Woolly Aphid		—	—					Lindane, Malathion
Cooley Spruce Gall Aphid		—	—					Lindane, Endosulfan, Malathion, Carbaryl
Balsam Gall Midge			—	—				Malathion
Eastern Spruce Gall Aphid		—	—					Lindane, Malathion, Endosulfan, Carbaryl
Spruce Needle Miner				—	—			Malathion
Spruce Mite			—	—				Kelthane
Allegheny Mound Ant			—	—				Chlordane
White Grubs		—	—					Chlordane
Pine Webworm						—		Carbaryl
Fir Tip Mining Sawfly								Control usually not necessary
Spruce Sawfly				—	—			Methoxychlor, Carbaryl
Balsam Twig Aphid		—	—					Lindane, Malathion

The lines indicate approximate time and number of treatments; the solid lines for northern New Hampshire, the dotted lines for southern New Hampshire.